THIRD ANNUAL REPORT

OF THE

CORNELL UNIVERSITY

AGRICULTURAL EXPERIMENT STATION

FOR THE YEAR

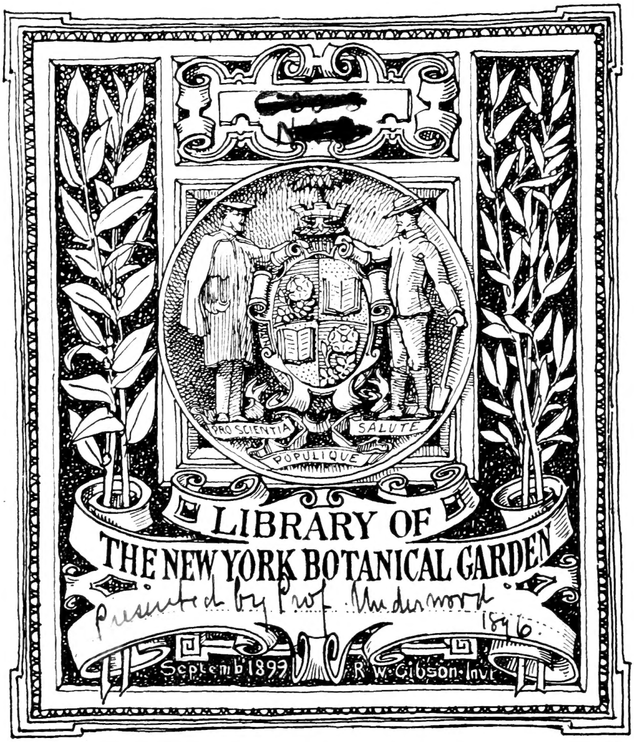
1890

ITHACA, N. Y.

Compliments of

I P Roberts,

Director



CORNELL UNIVERSITY,

COLLEGE OF AGRICULTURE.

THIRD ANNUAL REPORT

OF THE

Agricultural Experiment Station.

ITHACA, N. Y.,

1890.

"That art on which a thousand millions of men are dependent for their sustenance, and two hundred millions of men expend their daily toil, must be the most important of all; the parent and precursor of all other arts. In every country, then, and at every period, the investigation of the principles on which the rational practice of this art is founded, ought to have commanded the principal attention of the greatest minds."—JAMES F. W. JOHNSTON.

PUBLISHED BY THE UNIVERSITY,
ITHACA, N. Y.,
1891.

CORNELL UNIVERSITY.

Agricultural Experiment Station.

Offices of the Director and Deputy Director, 20 Morrill Hall.

Those desiring this Bulletin sent to friends, will please send us the names of the parties.

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LETTER OF TRANSMITTAL.

To His Excellency,

The Governor of the State of New York,

SIR :—

I have the honor to transmit herewith the Third Annual Report of the Agricultural Experiment Station of Cornell University, in accordance with the requirements of the Act of Congress, approved March 2, 1887, establishing the station. This Report consists of the following documents, viz :

The Report of the Director.
The Report of the Treasurer.
The Report of the Chemist.
The Report of the Botanist.
The Report of the Cryptogamic Botanist.
The Report of the Entomologist.
The Report of the Division of Agriculture.
The Report of the Horticulturist.
Appendix I.—Containing the ten bulletins published during the current year.
Appendix II.—Containing a detailed statement of the expenditures of the station.

In the Report of two years ago the assurance was given that it would be the policy of the University to render to the Agricultural Experiment Station the assistance of all the resources of the Col-

lege of Agriculture. It is one of the objects of the present Report to show the manner in which that promise has been fulfilled.

To the people of this state who are especially interested in the great work of raising and improving the condition of our agriculture, it is believed that the accompanying papers will prove to be of exceptional interest. The general reports will be found to give a somewhat full account of the manner in which the College of Agriculture and the Agricultural Experiment Station mutually assist each other, and thus subserve the great common interest for which they were both organized. The bulletins given in the first Appendix will show with what success the station has made use of the various facilities afforded.

I have the honor to be

Your obedient servant,

C. K. ADAMS,

President.

CORNELL UNIVERSITY,

Jan. 31, 1891.

PLATE I.—*The Proposed Agricultural Hall.*

REPORT OF THE DIRECTOR.

To the President of the Cornell University:

SIR :

I have the honor herewith to transmit my third annual report, together with those of the divisions of Chemistry, Botany, Entomology, Agriculture, and Horticulture; and also those of the Treasurer and Secretary of the Cornell University Agricultural Experiment Station.

The Act of Congress, approved March 2, 1887, establishing the Experiment Stations, provides, among other things, for publishing reports of progress from time to time. The many communications received in regard to the history, organization, and equipment of the Station, have led me to believe that a brief report of progress might be of interest at this time.

The reorganized station began its work April 30th, 1888, under exceptionally favorable circumstances. The University had already in its employ able men whose work ran parallel with that of the station, who had been selected on account of their known success in their several specialized lines of work. By making the station a department of the University, and by dividing its work into appropriate divisions, the trustees were enabled at the beginning to place at the head of each division of the station an experienced and trained specialist.

A plant, which in many lines was very extended, had already been provided for giving instruction to students, and as the station was established for the sole purpose of teaching, the plant became largely available for conducting investigations. The college was for the purpose of giving instruction to students in residence; the station for advancing knowledge and for giving help to all engaged in farming, without reference to age, previous training, or residence.

The reorganized station availed itself of a fully equipped chemical laboratory, provided for its exclusive use, and many lines of experimental work already begun. The professors who

took charge of the several lines of investigation had been engaged in experimental work to a greater or less extent, for the previous ten years, under the old organization.

The trustees were fortunate in securing the services of one of our graduates in agriculture, as deputy director and secretary, who had had several years' experience in editorial and experimental work. The president and trustees may well be congratulated on the skill and ability which they have shown in grafting a new department so successfully upon the parent stock.

The Original Station.—The Cornell University Agricultural Experiment Station was organized in February, 1879, for the purpose of promoting agriculture by scientific experimentation and investigation. The Board of Control consisted of the Faculty of Agriculture, together with delegates—one each—from the State Agricultural Society, State Grange, State Dairymens' Association, Western New York Farmers' Club, American Institute Farmers' Club, Central New York Farmers' Club, Elmira Farmers' Club, and Ithaca Farmers' Club. On June 20th, 1879, the board elected the following officers:

President, ... Professor I. P. Roberts.
Director, ... Professor G. C. Caldwell.
Treasurer, ... Professor A. N. Prentiss.
Secretary, ... Professor W. R. Lazenby.

The Executive Committee consisted of these four officers and President G. W. Hoffman, of the Elmira Farmers' Club.

The only funds at the disposal of the Station was a donation from Miss Jennie McGraw of two hundred and fifty dollars for the printing of the first report. It was published in 1880, and contained one hundred and thirty-three pages, and embraced the results of most of the work which had been conducted since 1874. The experiments covered a wide field of subjects, and had been duplicated (in many cases) for several years.

In 1881 the Trustees of the University made an appropriation of one thousand dollars, and appointed Dr. S. B. Newbury chemist to the station.

The following year an appropriation of one thousand one hundred and forty-five dollars was made, and Mr. F. E. Furry was appointed chemist in October, in place of Dr. Newbury who had resigned.

The second report was published in 1883 and contained one hundred and sixty-two pages. Like the previous one, it em-

braced a large class of subjects, most of which were entirely new. In 1883 another appropriation of seven hundred and fifty dollars was made by the trustees for the services of a chemist for 1883–4, Mr. Furry continuing to do the chemical work of the station for another year.

The third report was issued in March, 1885, and contained forty pages. Two articles in particular attracted wide attention, that on the quantity and value of manure of milch cows, and the effect of a maintenance ration. In the last experiment it was found that Wolff's standard maintenance ration, which up to that time was generally supposed to be reliable, produced a gain of one and one-tenths pounds per day per thousand pounds of live weight.

The editions of the three reports above mentioned becoming exhausted, and the demand for them continuing, it was decided to republish those articles which were of most general and practical importance. In accordance with this decision, in 1887 the trustees published a pamphlet of one hundred and forty pages, under the title "Studies in Practical Agriculture."

Reorganization.—On July 19th, 1887, the Executive Committee of the Board of Trustees resolved, "That the President and the Faculty of Agriculture be requested to prepare plans for the organization of an Agricultural Experiment Station in fulfillment of the requirements of the Hatch act, and to report at the October meeting of the board." After careful consideration of all the interests involved and of the work undertaken, the committee presented their report, which was adopted October 26th, 1887. It was very full and exhaustive, and closed with the recommendation, "that in order to give definiteness and unity to the work of the station, a committee be appointed, to be known as the Agricultural Experiment Station Council, such committee to consist of the President of the University, two other members of the Board of Trustees, one of whom shall be the President of the State Agricultural Society, and one of whom shall be chosen from the trustees resident in Ithaca; together with the heads of those departments in which the station work was to be done, viz.: the Professors of Agriculture, Agricultural Chemistry, Veterinary Science, Botany, Entomology, and Horticulture." Later the Professor of Cryptogamic Botany was added to the council. The report also provided for the appointment of a Di-

rector, and defined his duties and those of the heads of the six divisions into which the station had been divided. The council, at a meeting held in November, recommended that at least one assistant be appointed in each division as soon as needed, and made an adverse report on the policy of classing the assistants as fellows, and placing them under rules and regulations similar to those governing fellows in the University.

In April, 1888, the trustees appointed the Director and the Treasurer, and in May the Deputy Director and Secretary. Hon. H. B. Lord and Mr. George R. Williams, of the Board of Trustees were appointed auditing committee. The station was made a department of the University and President C. K. Adams its executive head. The Treasurer was authorized to disburse the funds of the station on presentation of bills approved by the Director. The station administration differs in no material points from that of other departments of the University, except that the receipts and expenditures are kept separate from all other funds.

From the first it was seen that the government funds available for buildings would be totally inadequate to provide room sufficient for the work contemplated. The professors at the head of the various divisions of the station were all engaged in University teaching, so that it was impracticable for them to do their station work in buildings detached from those already occupied. Such rooms as could be spared and easily fitted up were assigned to the station, and all the work of each professor was arranged for in one building, but the station as a whole was housed in five detached structures, exclusive of insectary, forcing-house, and farm buildings.

As students in the College of Agriculture became more numerous and station work increased, it was found that the room was much too limited. This led the Board of Trustees at their October meeting, 1890, to consider carefully the need of providing more ample and commodious quarters for both of these departments. By a unanimous vote they decided to appropriate $80,000 for the erection of a building for the use of four divisions of the College of Agriculture and the Experiment Station as soon as the funds therefor can be provided. It is hoped that this contingency will not occasion a long delay. This, when completed, will provide amply for both college and station, and

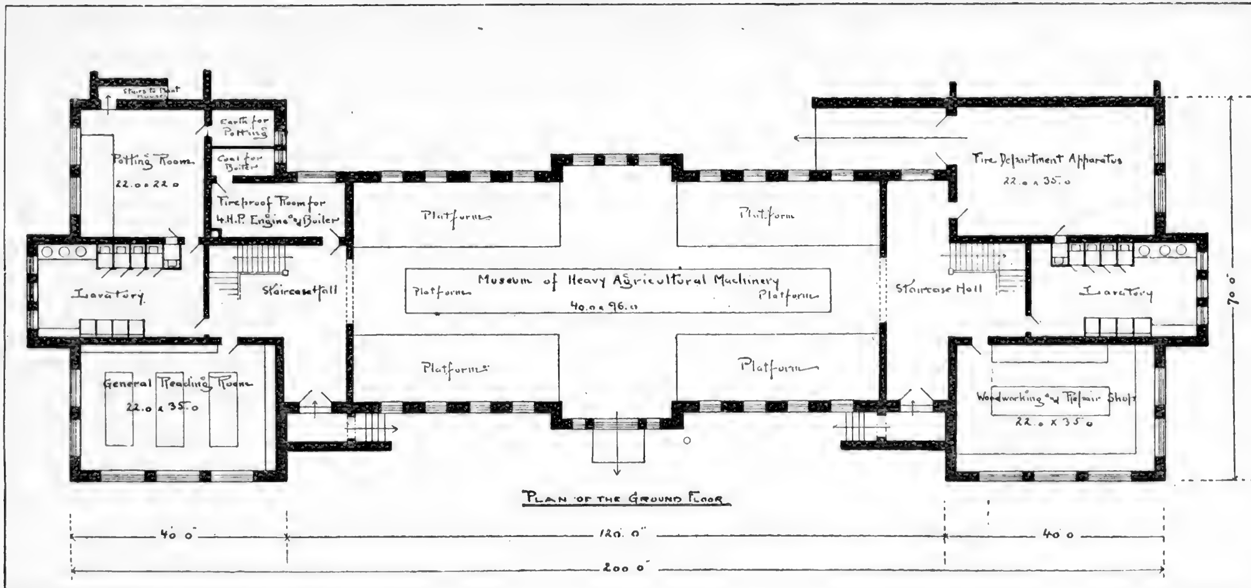


PLATE II.—*Plan of the Ground Floor.*

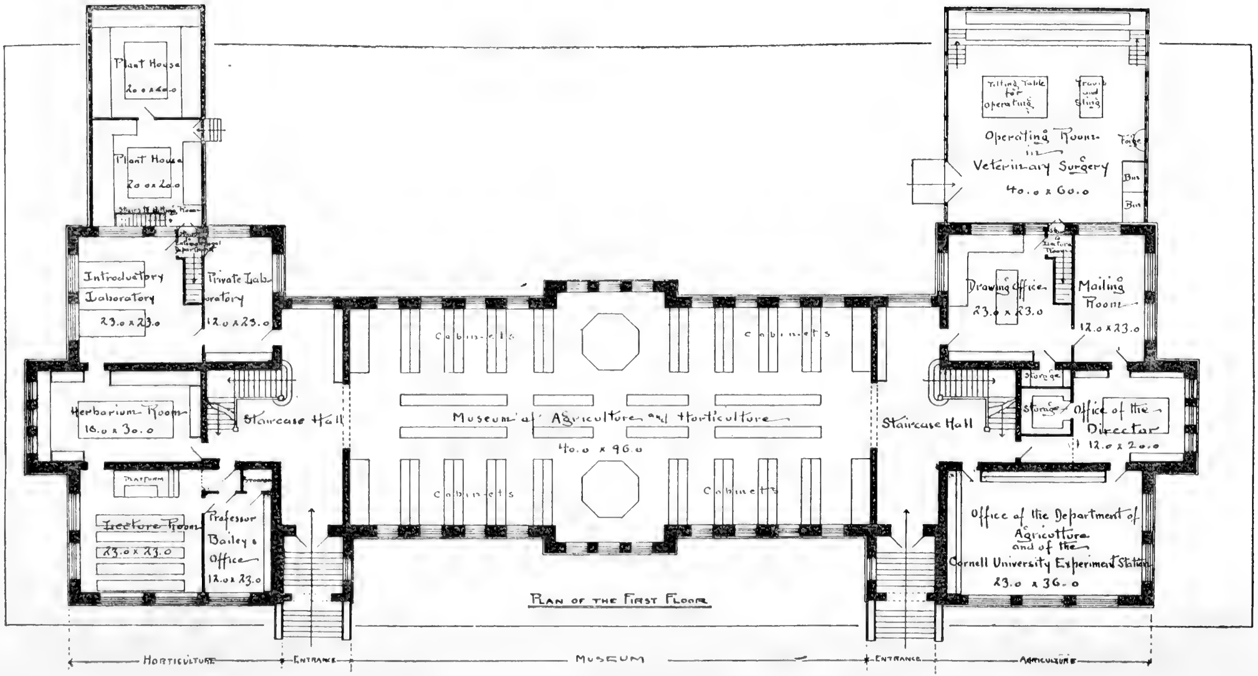


PLATE III.—*Plan of the First Floor.*

will not only promote each professor's work, but will place four closely allied divisions of the station in the same building—a great advantage over the present arrangement. While the building will be largely used by the College of Agriculture, all parts of it, except the class rooms, will be used by the station as well.

The preliminary sketches, which have already been prepared, show a four-story building (Plate I) about two hundred feet long, in shape somewhat like the letter H. The middle portion of the building is, through the four stories, given up entirely to museum purposes, while the ends are subdivided into class-rooms and laboratories, as described below. The building according to these preliminary plans is founded upon the motives of early Sixteenth Century French architecture.

The floor space will exceed 40,000 square feet, one-third of which will be devoted to a museum and cabinets of illustrative material and station appliances.

The ground floor (Plate II) will contain heavy farm machinery, and power for making tests, a fire-proof room for drying large samples of green material, a wood-working and repair shop, an earth and potting room, a general reading-room, and laboratories.

The first floor (Plate III) will contain not only a museum, but cases in which to place station material for the divisions of agriculture and horticulture, and will give eight rooms which will be used by both station and college as occasion requires. As the college and station work must always run parallel, it is expected that great economy of time and appliances will be secured, in concentrating the work of the professors so far as may be practicable. It is not expected that the plant-houses and operating-room will be used to any large extent by the station, as the departments for which they were designed have, or will have, detached buildings for conducting more extended research than could be carried on in them while they were being used for the purposes of instruction.

The second floor, (Plate IV), like the first, will be used exclusively by two divisions of the station and two allied departments of the college. Here, too, as in the other departments already spoken of, it is hoped to economize time and space and promote efficiency by placing the two-fold work of the professors in juxtaposition. Two staircases at the rear lead to the plant-houses and the operating-room, which are on a level with the first floor.

The third floor (Plate V) will contain a museum illustrative of the history and development of agriculture, and one of appliances which are or have been used for conducting experiments. On this floor also will be situated rooms and appliances for prosecuting special work which cannot well be carried on where interruption is likely to occur, and a general assembly room in which members of the station staff and others will have opportunity to illustrate and explain facts discovered in the line of their work to general audiences.

The insectary was erected in 1887–8 out of station funds at a cost of $2,600. It consists of a four-roomed two-story cottage, in the basement of which is the heater, potting, and hibernating rooms. The conservatory is a glass structure sixty feet in length. For detailed description, see the accompanying report of the entomologist.

During the years from 1888 to 1890, two large forcing houses were constructed for the use of the Horticultural division of the station, at a cost of $1,500. The University attached to them a building, which is used for offices and work-rooms. A third and somewhat larger forcing house than either of the others has been erected during the year by the University. This is designed for the use of the students, but will incidentally furnish additional facilities for experimentation. The remainder of the appropriation available for building purposes has been used in making changes in the barns and other buildings, in order to adapt them to the work of the station. It will be seen that the organization so far has been effected on a large and liberal scale, and that one department at a time has been provided with a large and convenient plant. The veterinary division has not yet been provided for, as it has appeared probable that the proposed new building could be made available for many of the requirements of this division. So it is likely that little advancement will be made in this direction until the Agricultural Hall is completed.

The Farm.—The farm consists of two hundred and sixty acres, thirty acres of which are in woods. On a portion of the land now used for pasturage it is hoped that a beginning may be made in experimental forestry. The Campus (see report of the Botanist,) and the buildings occupy about ninety acres and the horticultural experiment grounds fifteen. (See report of the Horticulturist.) The farm used in common by the col-

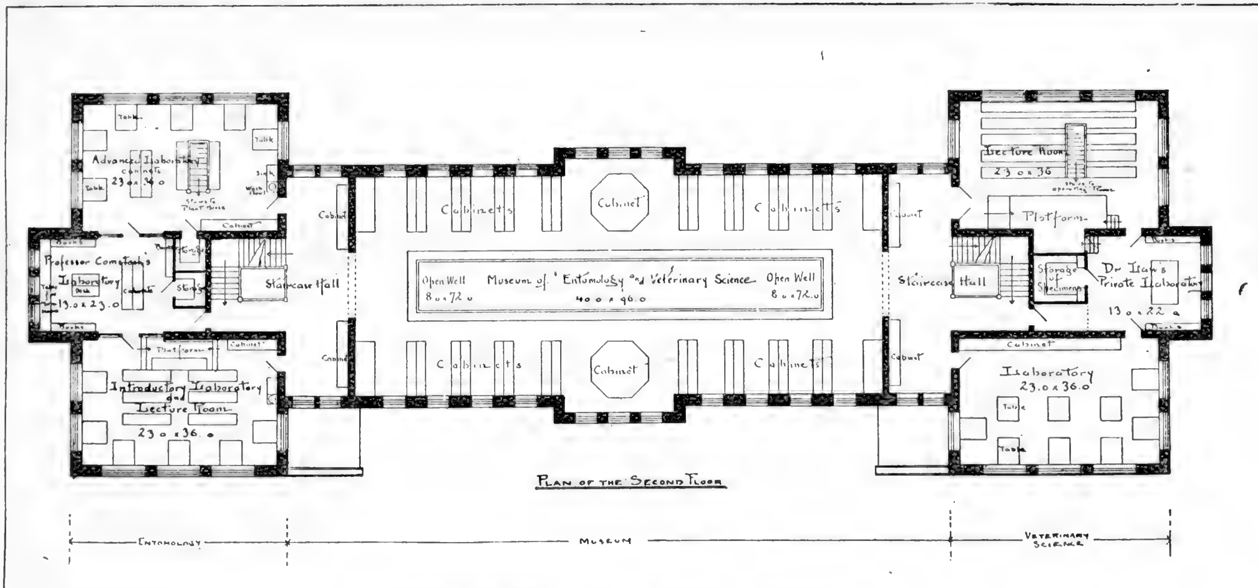


PLATE IV.—*Plan of the Second Floor.*

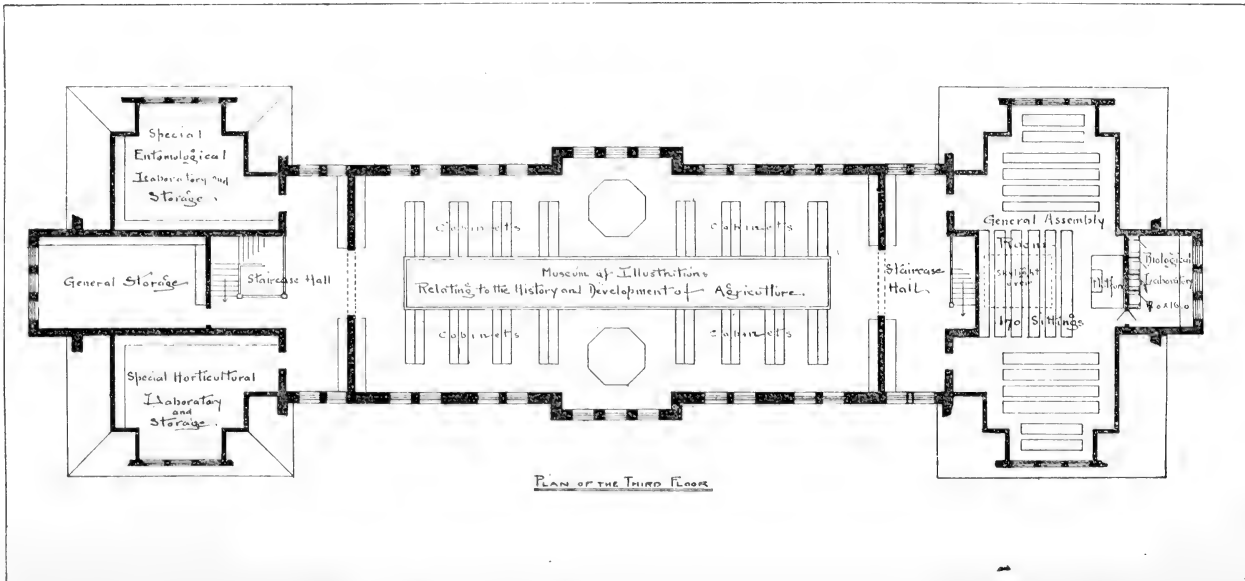


PLATE V.—*Plan of the Third Floor.*

lege and the station, embraces eighty acres of plow land and twenty of permanent pastures. Three and one-half acres of ground are laid out in twenty plots of one-tenth, twenty of one-twentieth, and twenty of one-fortieth acre each. These have been devoted to conducting experiments in various modes of culture of wheat, oats, corn, and clovers, and to testing of varieties. Of necessity, these investigations will have to be continued for several years before any reliable results can be reached. Field experiments are so difficult to perform on account of varying seasons and soil, that many of them reveal nothing of importance.

The general farm is used as occasion demands for making experiments on a larger scale than can be conducted on small plots; it has been found that some lines of experiment conducted on a large scale, are quite as helpful to the student in agriculture, as to the station.

Farm Buildings.—The farm barn (Plate VI,) was built in 1879, with the exception of an addition 30 by 40 feet, erected this year, is 160 by 104 feet, exclusive of a thirty-foot ice house which is attached to it. The lower story is nine feet high and is surmounted, except the recent addition, with posts twenty-four feet long at the sides and thirty-two feet at the gables.

The lower story contains a piggery, two covered yards, engine and boiler-room, root cellar, milk delivery room, platform scales, and accommodations for forty head of cattle.

The second story provides for farm tools and machinery, threshed grain, meal and bran, carriages and wagons, an office, and room for washing carriages and slaughtering and dissecting small animals, and stabling for twenty horses.

The third story provides room for one hundred tons of hay, fifteen hundred bushels of unthreshed grain, and stationary thresher, storage and repair room, corn cribs, and quarters for one hundred and fifty head of sheep.

The Dairy-House, which was constructed a year previous to the reorganization of the station, has been enlarged and furnished with additional appliances for experimental work. The present structure is 24 by 30 feet, one and one-half stories high, and contains, in addition to the facilities provided in the first structure for setting milk by the various systems and the manufacture of but-

ter, those for conducting investigations in the production of cheese in its various forms. The building, though not large, is ample for the work of the station. Since dairy husbandry is the great agricultural industry of the state, and embraces not only the art of production but that of manufacture as well, it is expected that this building will in the future, as in the past, be in constant use.

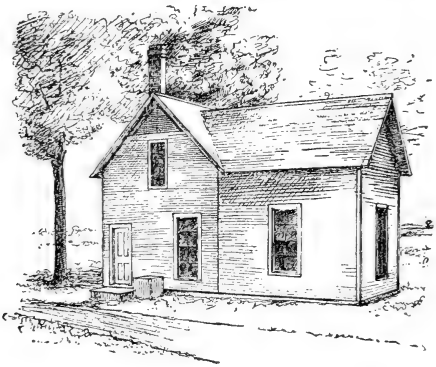


FIG. 1.—*The Dairy House.*

Thirty sheep, twenty swine, eight horses, twenty-five milch cows, and a score of chickens constitute about the average number of animals which are used for experimental and other purposes.

It will be seen that the plant provided by the university and station funds for the purpose of agricultural research, is extensive if not entirely complete in all its details. For a more detailed report of other buildings and appliances provided for the use of the station, I refer you to the reports of the professors at the head of the respective divisions.

During the year ten bulletins have been issued, a copy of each of which is herewith transmitted and made a part of this report. Twenty-five bulletins, of eight to ten thousand copies each, and two annual reports have been issued, during the thirty-two months that the station has been established. A large amount of work which is believed to have been of direct and immediate value to agriculture, but which cannot be set forth in bulletins, has been done during the year. The station staff have given many addresses at the various meetings of agriculturists, have answered numerous enquiries through the press and by letter, and have visited several sections of the state in order to render assistance in solving difficulties of a general character.

The mailing list has reached twelve thousand, and six thousand persons have acknowledged the receipt of the bulletins. Several hundred letters received annually from the progressive farmers of

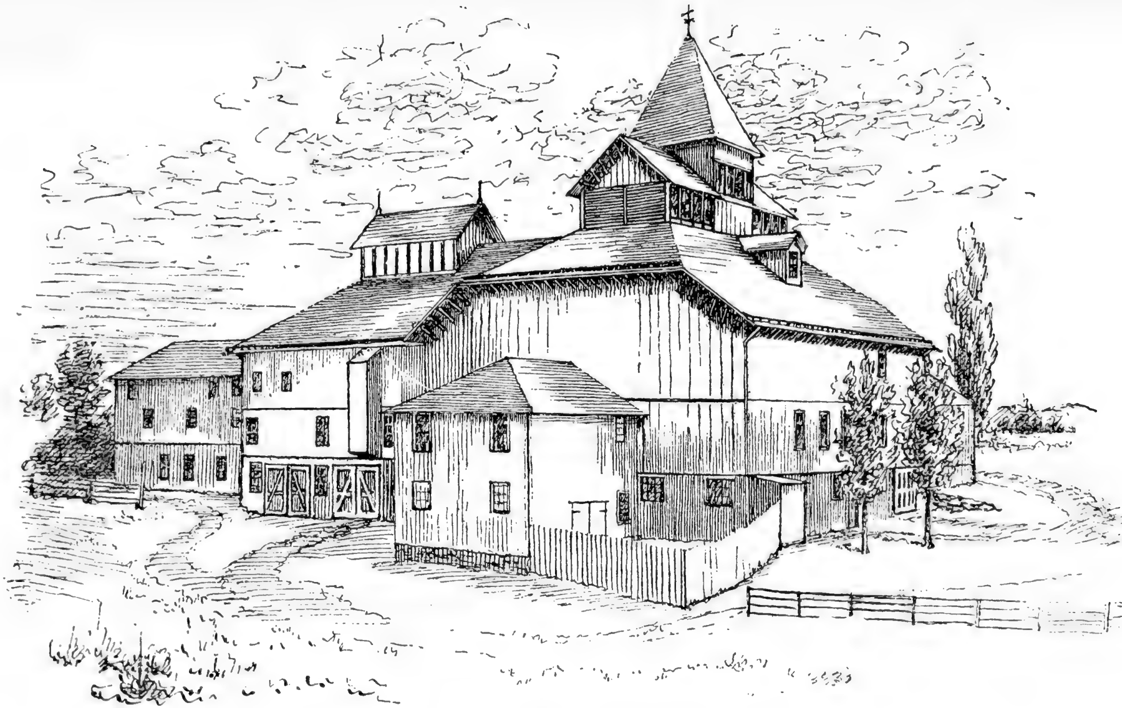


PLATE VI.—*The Cornell University Farm Barn.*

the state in commendation of the work done, testify to the full appreciation of the value of the station.

In accordance with the law, one copy of each publication is sent to each of the one thousand, seven hundred papers published in the state ; this wise provision enables as to reach nearly a million readers monthly.

Respectfully submitted,

I. P. ROBERTS.

REPORT OF THE TREASURER.

The Cornell University Agricultural Experiment Station,
In account with
The United States Appropriation.

		Cr.	Dr.
1890.	To Receipts from Treasurer of the United States, as per appropriation for year ending June 30, 1890, under Act of Congress approved March 2, 1887,		$15,000 00
June 30.	By Salaries,	$10,222 22	
	" Buildings,	749 99	
	" Printing,	1,466 86	
	" Office Expenses,	359 57	
	" Equipment, Labor and Current Expenses:		
	Agriculture,	490 37	
	Horticulture,	1,140 00	
	Entomology,	267 29	
	Botany,	195 91	
	Chemistry,	107 79	
			$15,000 00

		Cr.	Dr.
1890.	To Receipts for Produce sold:		
	Balance from 1888–9		$294 25
	Horticultural Division,		392 32
	Agricultural Division,		38 48
	Printing, (Rebates, etc.,)		20 85
	Office, (Balance on Draft,)		1 97
			$747 87
	By Printing,	$294 53	
	" Equipment,, Labor and Current Expenses:		
	Horticulture,	393 74	
	Balance to 1890–91,	59 60	
			$ 747 87

We, the undersigned, duly appointed auditors for the corporation, do hereby certify that we have examined the books and accounts of the Experiment Station of the Cornell University for the fiscal year ending June 30th, 1890; that we have found the same well kept and correctly classified as above, and that the receipts from the treasurer of the United States for the time named are shown to have been $15,000, and the corresponding disbursements $15,000, for all of which proper vouchers are on file, and have been by us examined and found correct.

(Signed.) H. B. LORD, } Auditing Committee.
GEO. R. WILLIAMS, } Board of Trustees.

I hereby certify that the foregoing statement of account to which this is attached, is a true copy from the books of account of the institution named.

(Signed.) EMMONS L. WILLIAMS,
Treasurer.

STATE OF NEW YORK, }
TOMPKINS COUNTY. } ss.

On this 7th day of January, 1891, appeared before me Emmons L. Williams, personally known to me to be the person whose signature is attached to the above certificate, and acknowledged that he executed the same.

(Signed.) HORACE MACK,
[L. S.] Notary Public.

REPORT OF THE CHEMIST.

Since my last report the facilities for the chemical work of this Station have been greatly improved. The rooms set apart for this purpose in the new chemical laboratory are larger, and so much more conveniently arranged than was possible in the old quarters, that more work can be accomplished with the same expenditure of time and labor; and there is ample space for two workers when additional help is temporarily needed; also, access is easy to other rooms of the chemical department, for the use of special apparatus, as well as to the chemical library. These rooms are provided by the University, but the cost of the work tables and plumbing, about $300, was paid out of the funds of the Station.

Parts of the east and south sides of the laboratory-room are shown in the annexed cut, (Plate VIII.) A large window occupies that part of the south side not shown, against which is a tile-covered table for volumetric work. On the east side the battery of six fat extractors may be seen; the flasks of all the extractors are heated in a long shallow water-bath; each extractor is connected with a coil of block tin pipe passing up through the condensing tank above. Beyond this apparatus, and outside the limit of the cut, is a battery of four distilling flasks for the Kjeldahl nitrogen determinations, each flask being connected with a block tin pipe passing through a tank of cold water and out at the bottom, for the delivery of the distillate into the receivers.

At the north end of the room is a large fume closet, in one end of which is the stand for four digestion flasks for the Kjeldahl nitrogen method.

Adjoining this hood is the Fletcher muffle furnace for incinerations. Under the floor of the fume closet a large steam coil is enclosed, leaving ample space above for drying purposes. On the west side is a large slate table for the blast lamp, and over this on the wall are the air and water baths. Adjoining the room on this side are the balance room and store room.

In May, Mr. W. P. Cutter, the assistant chemist, resigned in order to take the position of chemist of the Utah Experiment Sta-

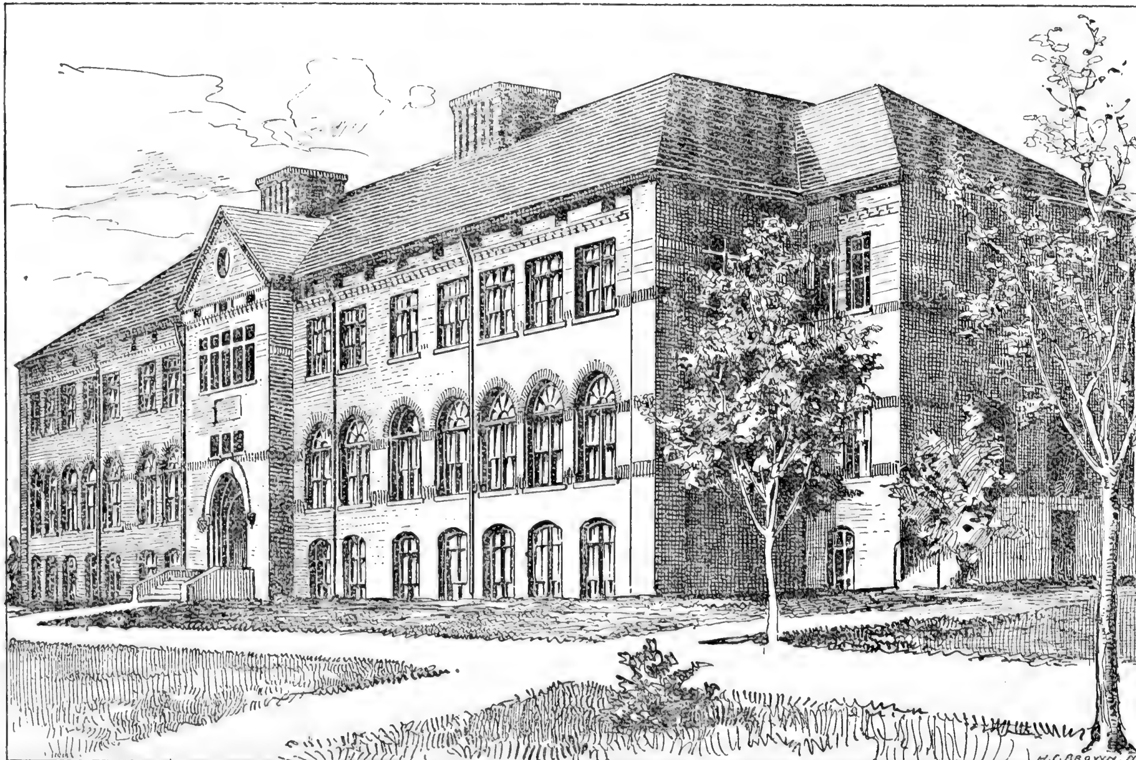


PLATE VII.—*The Chemical Laboratory of Cornell University.*

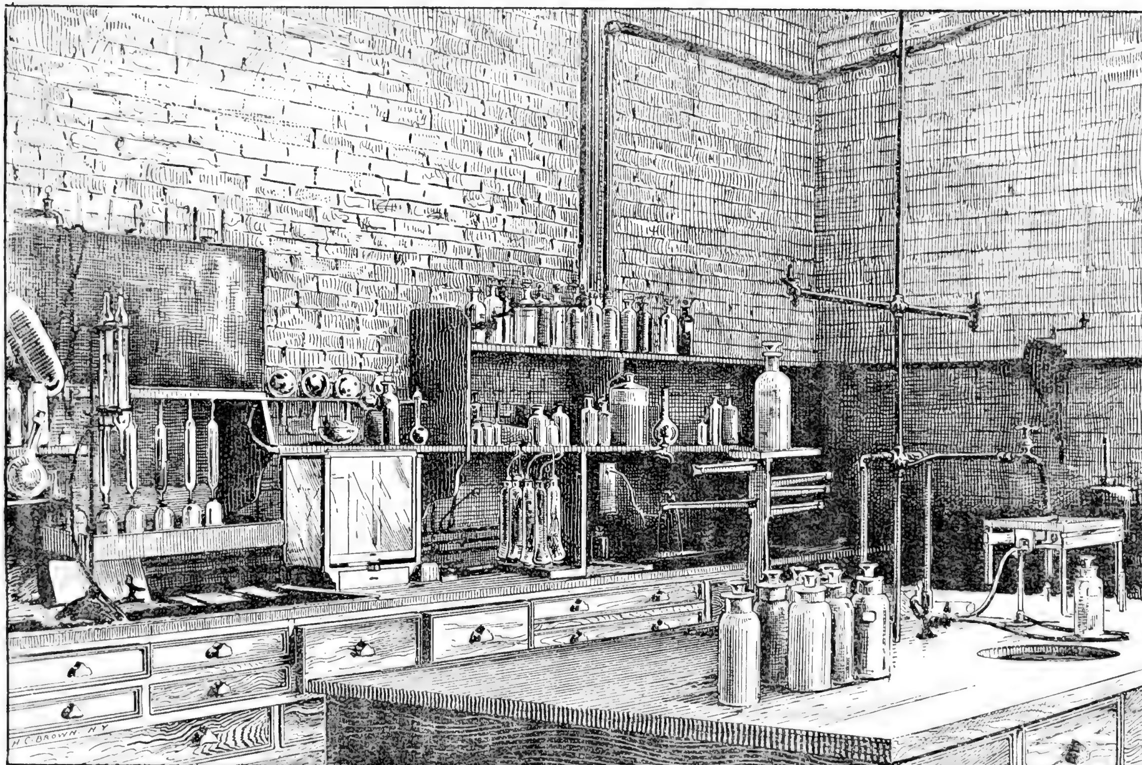


PLATE VIII.—*The Agricultural Experiment Station Room.*

tion. Mr. H. Snyder, who was appointed in his place, entered zealously on the work of his new position. The following summary of analyses made gives evidence of his industry. Nearly all these analyses were for the agricultural division of the station; they are reported in detail in their proper connections, in bulletins of the year, and are brought together and tabulated in Bulletin XXV.

SUMMARY OF THE ANALYTICAL WORK.

BY W. P. CUTTER, FROM JAN. 1 TO MAY 21.

Fodders: ensilage,	22	samples.
" miscellaneous,	9	"
Milk,	12	"
Sundries,	4	"

BY H. SNYDER, FROM MAY 21 TO DEC. 31.

Ashes,	2	samples.
Fodders,	18	"
For A. O. A. C.,	3	"
Fertilizers,	13	"
Insecticides,	5	"
Milk,	455	"
Sheep meat,	20	"
Sugar beets,	6	"
Sundries,	5	"

INCIDENTAL WORK.

Comparison of the paper coil method and the asbestos method for the determination of fat in milk.

Tests of Dr. S. M. Babcock's centrifugal method for the determination of fat in milk.

G. C. CALDWELL,
Chemist.

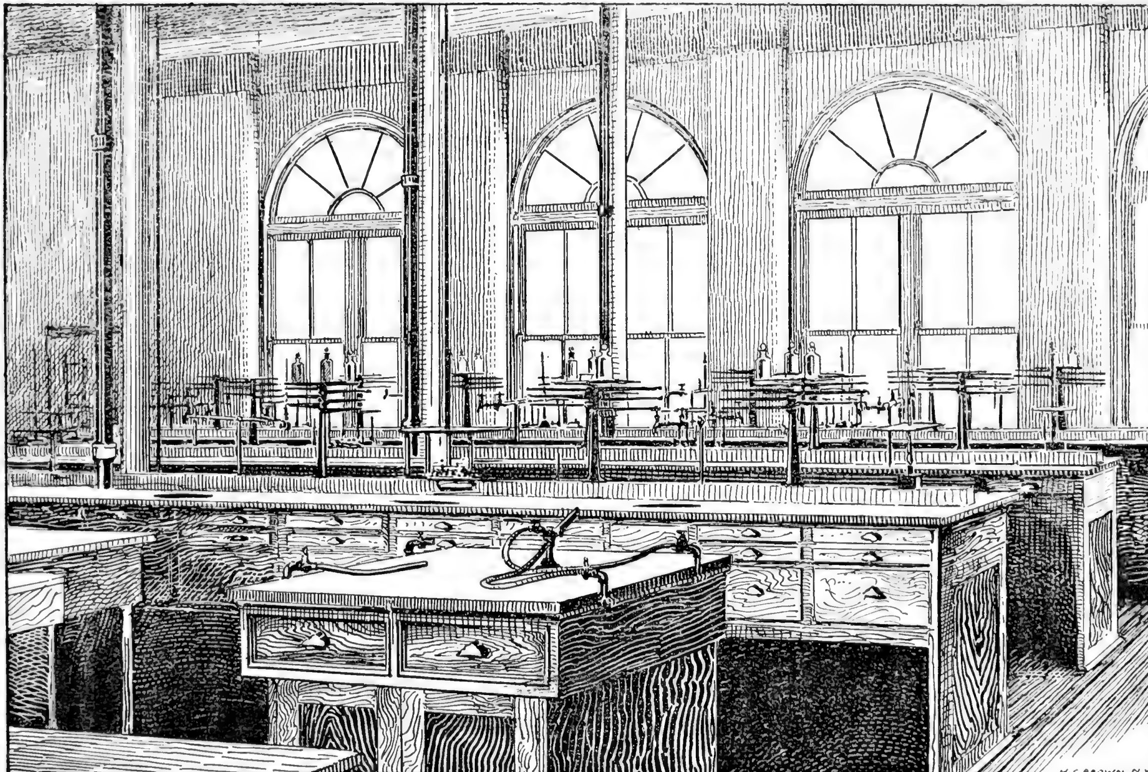


PLATE IX.—*A View in the Quantitative Laboratory.*

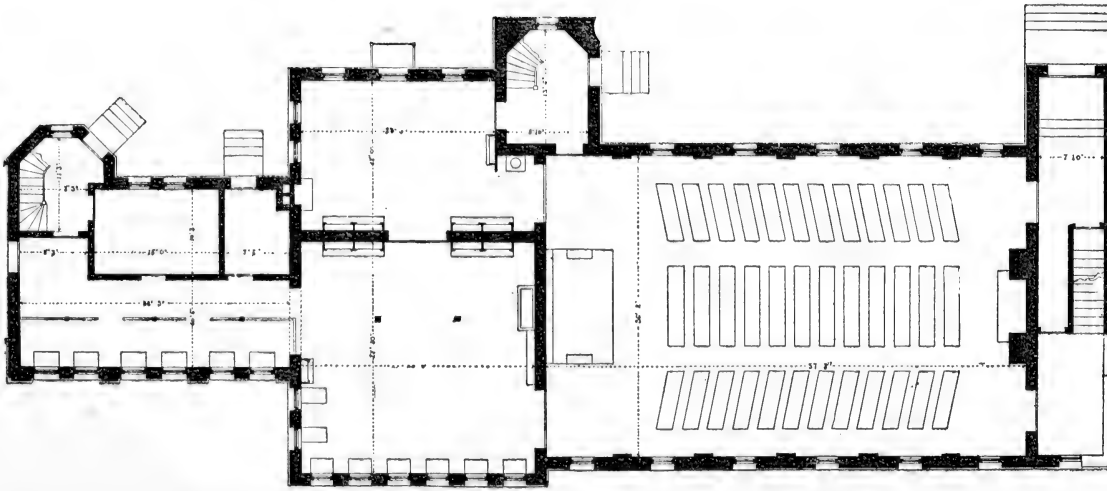


PLATE X.—*Plan of the Botanical Lecture Room and Laboratories.*

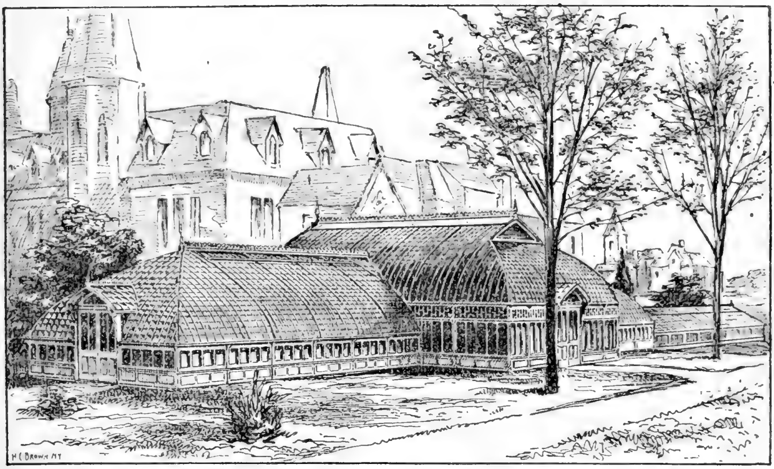


FIG. 2.—*The Sage Conservatories.*

REPORT OF THE BOTANIST.

The Botanical Department was organized at the beginning of the University in 1868. It was provided at the outset with fair facilities for instruction and considerable collections. Its general equipment and collections have been gradually increased during successive years. At the time of the organization of the University Experiment Station on the Hatch Act foundation, the department occupied suitable apartments which had been specially provided for it in the south wing of Sage College, a fine building donated to the University in 1872 by Hon. H. W. Sage.

These apartments consist of a large lecture room, thirty-six by fifty-eight feet, with sittings for one hundred and fifty-six students, which may be increased to two hundred as occasion demands. Adjoining the lecture room is the principal laboratory, sixty feet in length by twenty-eight feet in breadth at its widest part. This is well lighted by north windows and is supplied with work tables fixed to the wall so as to make them as firm as possible for microscopic work. Adjoining this laboratory and the lecture room,

is a laboratory and office, eighteen by twenty-three feet, for the use of the professor in charge of the department. A small room adjoining the laboratory is used by the assistant in charge of laboratory work. The arrangement of these rooms, the three entrance vestibules and the stairways leading to the floor above, are shown in the accompanying diagram, plate X.

At the east of the laboratory and connecting directly with it are the plant houses, built in 1881 by Messrs. Lord and Burnham, of Irvington. These are a special gift of Mr. Sage. They consist of five houses, forming together a structure forty-five by one hundred and forty-five feet in its extreme dimensions. The relative position and sizes of these houses is shown in the accompanying plan, plate XI. They are of different height, ranging from ten to twenty feet, the central and highest one being known as the Palm House. All are arranged for different degrees of temperature, so that a wide range of conditions adapted to a correspondingly wide range of plants is afforded. The houses are well stocked with a large collection of plants, chosen mainly for their use in botanical instruction and investigation. Underneath the laboratory are the potting room and boiler room, the houses being heated by hot water. The houses are built in every respect in the most thorough manner, and experience has shown that their working quality is almost perfect.

On the floor above the main laboratory is the upper laboratory, twenty-two by thirty-three feet, lighted on three sides, and originally intended mainly for introductory laboratory work. Adjoining this and connected with it by a broad, open archway, is the botanical museum, twenty-eight by forty-six feet. Here are kept the general herbarium and the collection of vegetable products, all arranged in suitable cases in systematic order, corresponding to the systematic arrangement of the natural orders of plants. On the floor above the museum, the third floor of the building, are the drying and pressing rooms, the apparatus rooms and the room for the duplicate herbarium specimens, of which the department owns many thousands.

The collection consists of the general herbarium, containing at least fifteen thousand species and a much larger number of specimens, the local herbarium containing specimens of all the species of flowering plants and ferns growing spontaneously in the

Cayuga Lake Valley and the area drained by the streams flowing into it; the herbarium of exotics, containing many hundred species of cultivated plants and varieties; and the herbarium of three thousand or more species of fungi. In the museum of vegetable products are collections of woods, seeds, fibers and fruits, the latter represented by both alcoholic and dried specimens. There are also many specimens of plant products, such as oils, gums, resins, substances used in medicine, and the like. The equipment in the way of facilities for instruction and investigation includes dissecting and compound microscopes for use in the laboratory, charts and diagrams for laboratory and lecture room use, apparatus for experimentation and investigation in plant physiology and a large collection of models for class room use, showing flowers and other parts of plants on a greatly magnified scale. In addition, the department owns a stereopticon specially constructed for its use, with several hundred views of plants or their parts, and the vegetation of different countries.

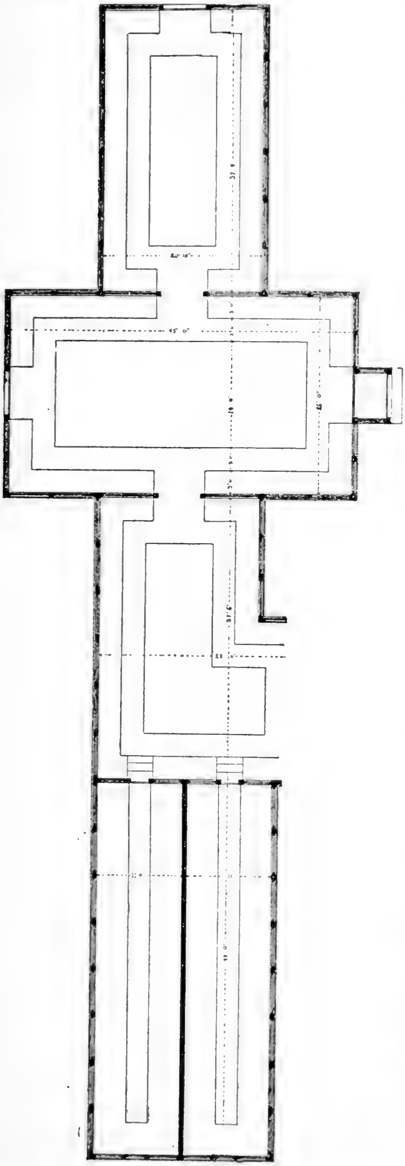


PLATE XI.

Besides this indoor equipment, the University grounds, embracing some fifty acres, are under the charge of the department. They have been

provided with suitable walks and drives and have been planted to trees and shrubs, both native and exotic, representing a large number of species and varieties. Much of the surface is in lawn, and in the vicinity of some of the buildings are flower borders and shrubberies. While the planting has been done mainly for the purpose of giving the grounds an orderly and attractive appearance, the advantages which are afforded to botanical instruction in the way of illustration and material for work, has not been lost sight of. Belonging to the department also, is a small garden, supplied with hot-beds and cold frames, containing nursery rows of young trees and shrubs, affording facilities for the growth of seeds and the testing of varieties, and for the planting out in the summer of a part of the greenhouse and conservatory plants.

Such in general was the equipment of the Botanical Department at the time the Experiment Station was organized. In the study of methods for the organization of the station, the question was considered as to whether this department, as in the case of several others, might not contribute to the efficiency of the station without detracting from the value and thoroughness of its principal work of instruction. If botanical work was to be undertaken at all, here was a large equipment brought together as the result of twenty years of labor and a large expenditure of money, much of which would be indispensible to station work. There were the several herbaria and collections useful in the identification of plants and seeds and in other ways; the well equipped plant houses were available for a wide range of experimentation on the growth of plants, their behavior under varying conditions, the effect of fertilizers used in pot culture, and the like; and the laboratories with their microscopes and apparatus were available for supplementing the work of experimentation or for the study of various problems in plant life.

The authorities of the University were not averse to the use of the department equipment for station purposes, so far as it could be done without lessening in any way the efficiency of university instruction. Accordingly the subject of botanical work to be undertaken for the station was considered. Many lines of work thought to be important presented themselves. Plant physiology, a subject specially mentioned in the Hatch Act, afforded a wide field for experimentation and research; in forestry, a subject of

great and growing importance to the state and nation, it was thought that something useful might be done ; and the disease of plants, considering the havoc and losses caused by the yellows of the peach, the blight of the pear, the black knot of the plum, and a host of other plant diseases, was also regarded as a subject urgently demanding attention.

Considering the equipment of the department and the existing arrangement within it of the work of instruction and supervision, it was thought that the most available subject to be taken up as station work was that last named above, the diseases of cultivated plants, and especially those caused by parasitic fungi. This was accordingly chosen and the work placed in charge of the chief assistant of the department, Assistant Professor William R. Dudley, whose study of cryptogamic botany had given him special fitness for the work. To afford him as much time as possible for carrying on the investigations called for by this new undertaking, Professor Dudley was relieved of all work of instruction for one term and a part of the instruction for the remaining two terms of the college year, the work from which he was relieved being provided for by the appointment of an instructor whose salary is paid by the University. In connection with this change in work, the arrangement of laboratories was so changed that all instruction in cryptogamic botany and histology, and all station work, was to be done in the upper laboratory, and all other laboratory work of the department in the laboratory on the main floor.

As a further preparation for station work, purchases of apparatus, books, and collections were made from station money. These were largely chosen by Professor Dudley, who was at that time in Germany on leave of absence. They consist in the main of an excellent Zeiss microscope with suitable accessories ; several collections of fungi, consisting of specimens representing a large number of species named by competent specialists ; chemical, bacteriological, and physical apparatus ; and a considerable number of scientific works relating to the cryptogamia, and especially fungi. In addition, large experimental and other tables, and cases for books and specimens, were provided.

With this equipment, the rearrangement of laboratories, and the appointment of an assistant instructor as above indicated, the station work was begun by the department in October, 1888. The result of the work thus far accomplished has been in part

embodied in Bulletins Nos. XIV, XV, and XXIV. The importance of these published results speak for themselves; but it should also be borne in mind, as stated in the report of this department for 1889, that in the investigations of plant diseases, a large amount of careful and pains taking work is called for which may not be productive of material suitable for publication in station bulletins.

In addition to the expenditure of station funds above noted, some expenditures were made at the organization of the station for a microscope, a small amount of chemical and physiological apparatus, and a collection of greenhouse plants, with the expectation that from time to time notes of minor importance might be contributed by the Station in addition to the more important subjects to which its main efforts were to be devoted. No expenditure of this kind, however, for salary or otherwise, has since been made, and although some work has been done or is still in progress, no results of sufficient importance for publication have as yet been reached.

All appropriations of station funds to the department, including the annual appropriations, have been, with the exception above noted, expended in improving and extending the equipment for the study of plant diseases, or for the current expenses in carrying on this work, or for the payment in part of Professor Dudley's salary. Besides, no charge is made to the station by the department for rent, lights, fuel, for the use of apparatus and collections, nor for the use of the plant-houses for carrying on various experiments involving, to some extent, the labor of the head gardener and his assistants. Further than this, the work of students carried on wholly for the purpose of instruction, is at times of value to the station. For instance, in the experiments on the strawberry leaf blight, the results of which are given in Bulletin XIV, one of the most important facts, from a scientific point of view, there recorded, was brought out by a special student in the course of a study of the life history of the fungus causing the disease. From this it will be seen that the department has made large contributions to the station in the way of facilities for carrying on its special work; in turn the department has received some added strength in certain lines from the station; but it is obvious that the former out weigh the latter in large proportion. Experience will no doubt suggest changes and improvements; but there seems to be no reason why the department and station may not work together to their mutual advantage.

A more complete statement in regard to the work on plant diseases, its nature, methods, progress, and present condition, prepared by Professor Dudley, accompanies this report.

A. N. Prentiss.

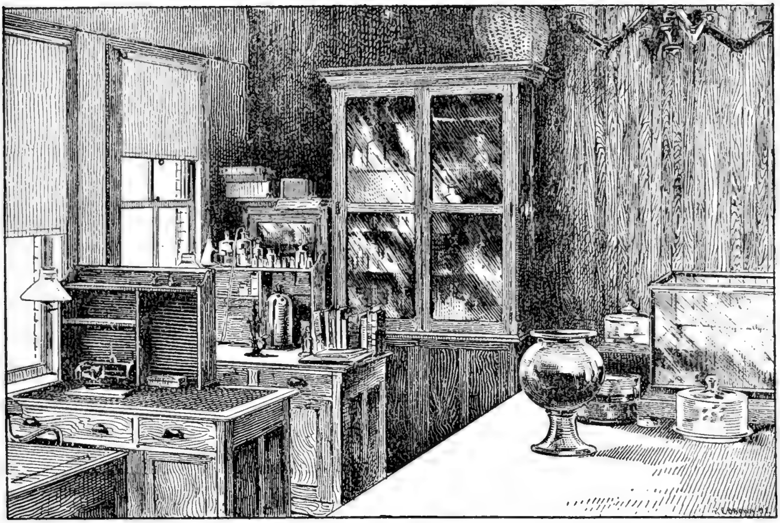


FIG. 3.—*The Laboratory of Cryptogamic Botany.*

REPORT OF THE CRYPTOGAMIC BOTANIST.

To the Director of the Cornell University Agricultural Experiment Station,

SIR :—

In compliance with your request, I submit the following description of the laboratory, and appliances for Cryptogamic Botany, and a report of progress in the work done in the interests of the station during 1890.

The two laboratory rooms in which the cryptogamic work is carried on, are on the second floor of the south wing of the Sage College ; the entrance from the campus being through the door next to the Cornell University flower conservatories in the rear of this building. The museum-herbarium room adjoining the laboratories, also contains the collections of fungi belonging to or used by the station, and the flower-conservatories have been used for the experiments relating to germination and artificial infection of fungi, in default of more suitable ones for such work.

The professor's private laboratory on the northwest corner is 10 x 15 feet, and contains his private botanical library and working tables.

The general laboratory for cryptogamic and histological work, adjoining it, is 22x22 feet, with a small eastern extension, containing a glass-ware case, and sink. The university instruction in Cryptogamic Botany and Histology is also carried on in these rooms throughout the college year, although a part of the students are obliged to have their work-tables in the adjoining museum. The advantages of the association, thus brought about, of the less-trained students with the more advanced, and with the processes of more advanced work are not to be ignored, but hardly equal the disadvantages of the excessive crowding of work, and the appliances for working.

In Figure 3, a portion of the north side of this laboratory is shown, including the two work-tables used during 1889–1890, by those who were carrying out the observations and experiments on the Clover Rust, and the Quince Blight. The farthest table is occupied this year by the present Fellow in Botany, and many of the appliances on this table, the section-cutter on the table behind it, and some of the apparatus on the large table seen on the right, are for the more refined methods of preparing, sectioning, and permanently preserving parts of plant-structure, the subjects of study in the laboratory. In investigating the mode of attack of fungus-mycelium on the tissues of the host-plant, we have found these methods of sectioning important.

The case in front contains the chemicals for immediate use in our work, and supports the jars for alchohol and distilled water. The large table seen on the right, occupies the entire middle of the room, and is utilized for artificial cultures, for temporary reception of apparatus and laboratory appliances, its drawers serving for the storage of various working materials. In this room is also the case for glass-ware, a platform for the sterilizing apparatus, necessary in preparing all cultures of fungi, and one of the cases for the fungi collections. The room is lighted by narrow windows, especially designed, we have been told, for laboratory illumination.

The collections available for use comprise the Ellis collection of North American Fungi, Ravenel's Fungi Americani, Mougeot and

Nestler's Cryptogamæ Rhenanæ, the larger part of Rabenhorst's Fungi Europæi, and Roumeguere's Fungi Gallici, the miscellaneous collections belonging to the Department, and the writer's private collection.

The microscopes of the Botanical Department are available for use when necessary, but the station itself owns three valuable instruments deposited in this department. It has also a considerable quantity of glass-ware, and is furnished with a limited supply of balances, vegetating, refrigerating, and spraying apparatus for carrying on investigations.

Since the last Annual Report of the experiment station, the cryptogamic work has been of a three-fold character. Investigations of certain specific plant diseases were carried through the year; a bulletin was published and contributions made to two other bulletins; and lastly, many fungi have been examined, and the names, characteristics and treatment of the same were furnished in the answers to correspondents sending specimens.

In the absence of any assistant in either my botanical or station work, I have gladly availed myself of the voluntary labors of one student and one resident graduate trained in this University, who desired experience in the biological study of fungi. The progress of their work was daily reported to me. I was thus enabled to suggest from time to time the necessary variations from the plan of investigation originally marked out for them; and I have only words of commendation for the earnestness of Miss Howell in her work on the Clover Rust, published in part in Bulletin XXIV, and of Miss Porter in the researches on the Quince Blight, not yet completed or published. While this cannot take the place of permanent assistance, it would be well never to lose sight of the mutual benefit of this relation between the cryptogamic work and the training of those who may be able to advance the interests of scientific investigation elsewhere.

Of the work planned for the past year, that on the Clover Rust needs no comment beyond reference to Bulletin XXIV. The investigation of the blight of quince leaf and fruit presented unexpected difficulties. So far as known, the essential character of the fungus and the disease it occasions, together with drawings of the ordinary spores, were given in Bulletin XV. But its mode of passing the winter and of attacking the quince in the spring, were quite unknown. Sev-

eral distinct lines of investigation were planned, and from very careful observations we are enabled to say that the hibernation of the species must be chiefly by means of the ordinary spores mentioned above, and not by ascospores. The former were found on the fallen leaves at various times during the winter, and were capable of germination and vigorous growth. Experiments showed that these spores directly infected the host when sown on plants especially cultivated for the purpose, and we believe, although the evidence is not wholly conclusive, that in nature the source of infection in the spring is wholly from the fallen leaves of the previous year, or from the soil upon which they have rested, and that the spores are probably blown in the rain or dust to the young quince leaves. The utility of complete destruction of all diseased leaves as fast as they appear, especially in quince nurseries, is at once obvious; and the raking up in the autumn and burning of all fallen leaves and waste fruits in quince orchards is advised. Spores could not be found lodged in bark or bud-scales in close proximity to the opening bud, as we had expected; indeed none of our investigations thus far indicate a source of infection other than we have described.

The long search for the second or ascospore stage, supposed by Sorauer to be connected with this fungus, produced interesting results of scientific but not practical importance, which will be reserved for Miss Porter's final statement of her work.

It is clear that certain varieties are more susceptible to the attack of this parasite than others. As an illustration, the Angers was badly infested, but the Meech, growing beside the former on the University grounds, was nearly free.

If this disease is already firmly established in an orchard or nursery, and if an heroic remedy is really necessary, we particularly call attention to the Bordeaux Mixture, the formula given on p. 53 (Bull. XIX) of the current year. For account of its successful application, see *The Garden and Forest*, 1889, p. 582; Circular 8, U. S. Dept. of Agr., Div. of Veg. Pathology, 1889; and Bulletin XIV, Ohio Experiment Station.

Some time was spent on the examination of the various fungi attacking in 1890 with particular virulence the fruit crops of Western New York, and in reporting on the same. The apple-scab fungus (*Fusicladium dendriticum*) in particular received careful consideration, a summary concerning which is given on

pp. 50–52 (Bull. XIX) of the current year. Whether the fungus attacks the apple flowers and destroys them, or whether it reserves its attack till the young fruit is set, is an important point raised in this Bulletin; and it will be noted that our negative conclusions as to the first proposition, made quite independently, agree substantially with the authorities quoted on p. 48 of that publication. Subsequent inquiries developed the fact that in certain sections, the cherry blossoms withered and fell in clusters, much as the apple blossoms did. The *Fusicladium* does not attack the cherry, indeed no destructive fungus is known on young cherries likely to produce the effect mentioned. The failure of the apple crop, therefore, during the last season, was probably due primarily to a physiological disturbance (too low temperature at the time of the blossoming, it is thought); the young fruits which survived this first shock were then attacked by the apple-scab and the curculio, the conditions favoring the activity of both. The trees were also weakened by the attack on the foliage of the apple-scab, and the wholesale destruction of the crop under these circumstances is not surprising. Careful observations will be made in the future to ascertain if the fungus does or does not attack the flowers, as work will be continued on this disease during the winter and spring.

Pear leaves, greatly discolored by a blackish blister, were sent in at various times during the summer. In answers, and in Bulletin XIX, is indicated my belief that it was not due to a fungus but to the work of a gall-mite. I am glad to call the attention of correspondents to the timely paper by Professor Comstock on this gall-mite, (*Phytoptus pyri*), on p. 103 of Bulletin XXIII, a paper called forth by the above mentioned interest on this disease.

There seem to be two aspects to the destructive "Clematis disease." Prof. Comstock, in his exhaustive paper on the Nematodes, has made clear the relations of these parasites to the Clematis roots; but he has called my attention to the evidence that the presence or absence of the nematodes has in many cases no relation to the disease. Material has been secured and work just begun, with a hope of finding something further in regard to the origin of the disease.

The Hollyhock Rust has been at intervals under examination and many facts and observations collected concerning it, with the expectation of continuing the work into next season.

A series of experiments on the optimal temperature of germinating spores has been instituted. A few species only have been taken up, but thus far fungi which thrive best in a cold, wet season are found to prefer a low germinating temperature (See experiments on the Clover Rust, Bull., XXIV, pp. 135–138). Those thriving in a hot summer show a corresponding high optimal temperature.

It is not difficult to see that definite information on the limits of germination of the spores of each of our troublesome fungus parasites, might be of great service to owners of green-houses and forcing-houses. The preservation of a specific temperature, not injurious to the host plant, might deprive the fungus in certain cases of its power of attack.

It is apparent that many plant diseases have their basis in some physiological derangement in the plant itself; and that a better knowledge of the conditions of the health and hygiene of various forms of green-house plants is quite as essential as a knowledge of the particular mineral poison which will destroy the parasite likely to appear after the host has fallen into ill-health. These questions of environment will no doubt be eagerly taken up by the vegetable physiologists of America, who find few subjects worthy of their powers and their training and are forced thereby into other fields of exertion.

W. R. Dudley.

FIG. 4.—*Interior of Insectary.*

REPORT OF THE ENTOMOLOGIST.

To the Director of the Cornell University Agricultural Experiment Station:

SIR :—

In compliance with your request for a report on the progress of the Entomological Division of this Station, I beg leave to submit the following :

Facilities for Entomological Experiments.—At the time the station was reorganized under the provisions of the Hatch Act, the Entomological Department of the University in addition to being

well equipped for the work of instruction had already made considerable provision for carrying on investigations in economic entomology; and two reports on insects injurious to vegetation had bcen published by the station.

The equipment available at that time for the work of the station consisted of a comparatively good entomological library, microscopes, breeding-cages and other apparatus for the study of insects, and an extensive collection of named specimens.

Great care and considerable expense had been devoted to the building up of this collection. For, owing to the large number of species of insects in our fauna, no entomologist can be expected to know more than a very small proportion of them. And when insects are received for determination, it would often be very difficult to name the specimens if we had no collection of named insects with which to compare them.

In the course of making this collection we have received the generous aid of a large proportion of the more prominent entomologists of this country in determining the specimens. In the case of nearly every order of insects, the specimens illustrating that order in our collection have been determined by the highest authority on the American representatives of that order. We can, therefore, feel reasonably sure that the determinations are accurate.

In some respects our collection is a remarkable one. Thus of the *Coccidae* or Scale insects, one of the most important of families from an economic standpoint, we have the largest collection in existence. And of the entire Order *Hemiptera*, or bugs, our collection of the American forms is better than that possessed by any other institution in the country. In several other groups our collection though not comparatively so important as in the groups just mentioned, is really quite extensive. In fact if we except the great collections at Cambridge and Philadelphia, that of Cornell University holds a high place among those of this country.

The enlargement of the scope of the work of the station rendered possible by the support given it by the provisions of the Hatch Act necessitated an increase in its equipment. In the work which we had been doing in the study of insects, we had been seriously embarrassed by the lack of a suitable place in which insects could be studied while actively infesting growing plants, and where experiments in the destruction of insects could be tried. A place was needed where all of the conditions of growth of both plants

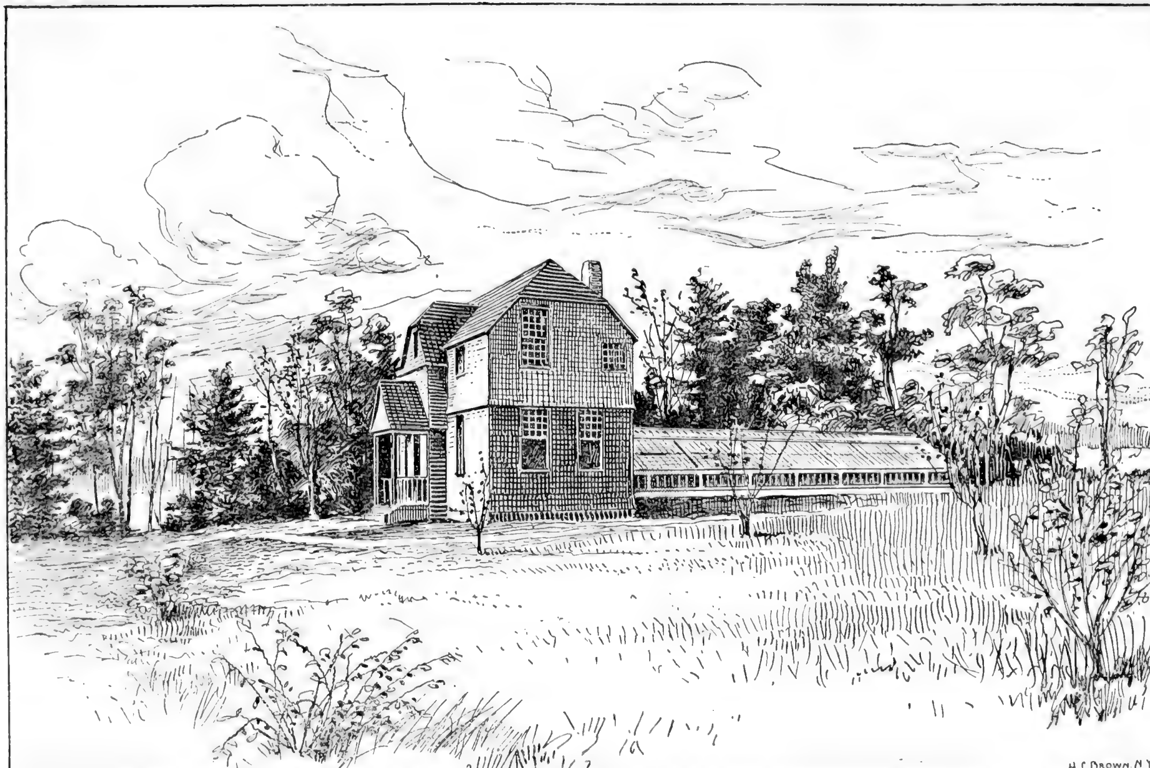


PLATE XII.—*The Cornell Insectary.*

and insects could be under control. It was therefore decided to erect a laboratory specially designed for carrying on work in experimental entomology. This Laboratory of Experimental Entomology, or Insectary as it is conveniently termed, is an exceedingly useful addition to the equipment of the department. It has proven to be of even greater service than was expected at the time it was built. We are now able to carry on many experiments, the conducting of which would be impractical without it.

A description of our insectary was published in Bulletin III. of this station. Immediately the importance of the facilities of such a building was recognized by other entomologists. And since that time several of the experiment stations have made similar provisions for carrying on their entomological work.

The Cornell Insectary, Plate XII, consists of a two-story cottage with a conservatory attached. Upon the ground floor of the cottage there are two laboratories for the entomologist and his assistants, and a dark room for photographic purposes. In the second story are quarters for a Janitor and a shop and store-room for apparatus. In the basement there is a boiler for heating the building and conservatory, conveniences for potting plants, a coal cellar, and a cold-room for the storage of hibernating insects. The conservatory, Fig. 4, is essentially the same as if constructed for botanical purposes; the foundations are of stone and brick, and the superstructure, of iron, wood, and glass; it is supplied with slate plant-tables at the sides, and with wooden tables in the centre. It is divided by a transverse partition into two rooms, each 30 feet in length. One of these is used as a hot-house, the other as a cold-house. The slate tables along the sides of the conservatory are covered with gravel; here are kept the plants growing in pots, and those breeding-cages from which water is allowed to drain. While upon the wooden tables in the centre of the room are kept the breeding-cages from which there is no drainage.

In the equipment of the building special pains have been taken to secure good apparatus for microscopic and photographic work. Our outfit includes, besides other apparatus, a Zeiss microscope with the new apochromatic objectives, and a photo-micro camera. The shop is furnished with a work-bench, and tools for use in making and repairing apparatus; and the conservatory is supplied with the ordinary conveniences for a building of this kind.

The cold-room for the storage of hibernating insects, referred

to above, merits a somewhat fuller description. It is adapted for the storage through the winter of pupae and other hibernating insects. The room is a dark one built in one corner of the basement. The partition separating it from the rest of the basement is a double wall of matched lumber and building paper, enclosing an air-space. This is rendered necessary by the high temperature of the basement, due to the presence in it of the heating apparatus. There is an inlet for cold air, formed by an 8-inch tile pipe extending under the foundations of the building and opening outside. There is also an outlet for warm air, made by leaving an opening into two of the spaces between the studding of the outside wall, these spaces being furnished with another opening through the side of the building just beneath the eaves. The outlet beneath the eaves of this flue is furnished with a hinged door which can be opened or shut by means of a cord; the size of the inlet for cold air in the floor of the cold-room can also be varied. In these ways the temperature of the room can be kept under control. The room on the ground-floor immediately above the cold-room is the laboratory, and near the assistant's table there is an opening covered by a pane of glass into the outlet-flue of the cold-room; in this flue, opposite the pane of glass, there hangs a thermometer, by means of which the temperature of the air that is escaping from the cold-room can be easily ascertained.

Since the establishment of our insectary an extensive series of experiments in tracing out the life histories of certain insects injurious to vegetation, and in determining the best methods of checking their ravages have been carried on. Nearly two hundred different species of insects have been studied. But the greater part of the work has has been concentrated upon a limited number of these. Thus during the past year, although we have bred a large number of species, keeping careful notes on the transformation of each, more than half of the work done has been devoted to experiments designed to determine the most practicable methods of combatting wire-worms and millipedes. It has seemed better to concentrate our energies as much as practicable upon a few problems of first-class importance. Still the demands upon us for information regarding a great variety of questions is such that a limit is set to the degree in which we can specialize. For this reason although, as just indicated, the chief part of our experiments have been in another direction during the past year,

the publications of the entomological department have been devoted to Insects Injurious to Fruits, more inquiries having been made of us regarding these insects than regarding all others.

Plans for the Future.—The additional facilities which will be afforded by the proposed building for the College of Agriculture will enable us to extend still further the entomological work of the Experiment Station. The increased space for museum purposes will enable us to greatly extend our exhibition of material illustrating applied entomology. But more important than this, the spacious laboratories, together with the plant-houses attached will afford opportunity for much work in experimental entomology by the advanced students in the College of Agriculture. At present the demand for opportunities for doing this work is greater than the department can supply without interfering with the work of the experiment station force. And we have been obliged to limit the use of the insectary by students to those seniors who are writing theses on subjects of immediate application to agriculture. It is hoped that in the near future we can offer an extended course on methods of entomological experiments, and give all students desiring such work an opportunity to conduct investigations in this field.

It is hoped that in this way the day will be hastened when the farms of the graduates of our College of Agriculture will become to a certain extent experiment stations.

The plans of the proposed quarters for the entomological department are shown on Plates III to V. The principal laboratories are to be on the second floor of the building, and at the north end, as north light is the best for work with a microscope. The experimental work of the department will be carried on in the advanced laboratory and in the plant-houses. Easy access to the plant-houses will be had by means of a staircase indicated on the plans. The museum, in which will be placed the collections of named specimens already described, will also be readily accessible, being on the same floor as the laboratories and separated from them only by a hall.

Work of the Year.—It is impracticable to describe in detail in this place the work that has been carried on in the insectary. In general it has consisted of completely or partially tracing out the life histories of certain insects injurious to vegetation, in experiments with insecticides, and in the publication of a bulletin on Insects Injurious to Fruits.

Among the insects whose life histories have been studied are several species of wire-worms, a millipede very destructive to melons, a considerable number of insects injurious to forest and shade trees, two previously undescribed insects infesting roses to an injurious extent, several pests of hot-house plants, and those insects injurious to fruits described in our bulletins on this subject.

The most extended of our experiments with insecticides have been those upon wire worms already referred to. The results of these experiments have been rather discouraging, being almost entirely negative. We are delaying the publication of these results in the hope that we shall soon be able to discover some practicable way of combating these pests. But we shall not delay much longer; for we feel that even our negative results are important; as they indicate the futility of nearly all of the commonly recommended methods of fighting these pests. For example, we have determined that our most common species of wire-worm cannot be destroyed by the use of salt in quantities not injurious to field crops. Although this knowledge does not aid us in combating the wire-worms, it will save the wasting of salt in a futile effort to destroy these insects.* We have also demonstrated the impracticability of starving wire-worms in the soil by sowing either buckwheat or mustard as has often been recommended, or even by starving them by clean fallow. These conclusions have been reached by a large number of experiments, the details of which will be published later.

In our studies of the life history of wire-worms, an interesting point was determined, which is of some practical importance, and will therefore be mentioned here. Wire-worms live for several years in the worm or larval state. When the worms are fully grown they change to pupæ. This takes place in the species that commonly infests field crops during the summer. The pupa state lasts only a short time, the insect assuming the adult form in the latter part of the summer. But, strange to say, although the adult state is reached at this time, the insect remains in the cell in the ground in which it has undergone its transformations till the following spring, nearly an entire year. With most insects only a very short time is required, after the change from the pupa to the

* It is possible that the use of salt results beneficially by driving the worms deep into the soil and thus giving the young plants a chance to start. Experiments will to tried to test this point.

adult state, to allow the body to harden, and the insect to become fitted for active life. But in this case the quiescent period after the adult form is reached is not only of long duration but appears to be necessary to the life of the insect. For in every case where the soil in the breeding-cages was disturbed after the insects had transformed, the beetles perished in the soil. The only way in which we have been able to rear active adults, has been to leave the soil in the breeding-cages undisturbed from midsummer till the following spring.

This experience clearly indicates that by fall plowing we can destroy the beetles in the soil, and thus prevent their maturing and depositing eggs the following season.

In closing this report the writer wishes to acknowledge the efficient aid, in the work of the station, of his assistant, Mr. M. V. Slingerland.

JOHN HENRY COMSTOCK.

REPORT OF THE AGRICULTURIST.

To the Director of the Cornell University Agricultural Experiment Station :

SIR :—

The work of this Division of the Experiment Station has progressed most satisfactorily during the year. Beside completing the work outlined in my report of one year ago many new lines of investigation, particularly in the branch of dairy husbandry, have been taken up and it is believed that some results of importance have been reached.

There have been published during the year three bulletins and several short articles in the "Omnibus Bulletin." The bulletins were :

No. XVI, Growing Corn for Fodder and Ensilage, detailing the results of a comparative trial of some forty varieties of ensilage corn and giving additional data as to the best period for cutting corn for ensilage.

No. XX, Cream Raising by Dilution and Variations in Fat of Milk served to Customers in Dipping from Cans.

No. XXII, On the Effect of a grain ration for Cows at Pasture, giving the results of the repetition in 1890 of the experiment on the same subject first reported in Bulletin XIII, December 1889.

Beside the above the results of the feeding experiments carried on the winter of 1889-90, the experiments on the production and waste of manure carried on through the past season, and some additional data on the subject of cream raising are now awaiting publication.

During the year the facilities for experiments with animals have been largely increased by additions made to the barn that are described and illustrated in detail in the report of the Director. With this new equipment the work of animal investigation has been enlarged to include some of the breeding problems as well as feeding, and for this purpose an excellent young male pig of the Poland China breed has been purchased, and through the courtesy of the Hon. David S. Collins, Secretary of the Rhode Island State

Board of Agriculture, two young sows of the breed that run wild in the forests of the Southern States, have been procured from Florida. The additions to the barn have also made it possible to begin some experiments in the breeding and feeding of poultry an important branch of farm economy that has as yet received but little attention by experimenters.

The season of 1890 was a disastrious one so far as securing results from field experiments are concerned. The floods of the spring that made it almost impossible to plant at the proper time, or in a proper manner, were succeeded by a short, but severe, midsummer drought, which in connection with the late and wet spring, materially interfered with the development of the crops, particularly corn. Consequently our reports for the year are barren in the line of field experiments.

The details of the work in the fields and barns have been since the first of July, in the hands of Mr. Clinton D. Smith, Assistant in Agriculture, to whom much credit is due for careful, accurate and painstaking work.

Respectfully submitted,

HENRY. H. WING.

REPORT OF THE HORTICULTURIST.

To the Director of the Cornell University Agricultural Experiment Station:

SIR :—

The work of the horticultural division for the year just closing has been in all respects satisfactory. A large amount of experimental work has been inaugurated and two or three important experiments have received much attention. A large part of the endeavor of the year, however, has been spent directly upon constructive matters. The equipment of the division is now assuming shape, and there is every reason to believe that in the coming years work of the very highest character can be done.

Perhaps the most important feature of the horticultural work thus far, is that associated with the forcing structures. When the horticultural work fell into my hands, about two years ago, there was nothing with which to begin operations. A bare and open field, covered with snow, was the place selected upon which to build glass houses. The building was begun in January, 1889, under great difficulties of weather. A small structure, twenty by sixty feet, was erected, heated by steam, a steam boiler being placed in a rude cellar at one end, with a temporary shed roof over it. This house cost $750.00, approximately, and was completed in time to start plants for the year's operations. In the fall of 1889, two more glass houses were erected, comprising a total area of twelve hundred square feet. In addition to these, a large work room and photograph gallery and other rooms were erected, and during the winter of 1889–1890 a considerable series of experiments was undertaken. In the fall of 1890, three other glass houses were erected with additional work rooms, which at this writing are just being fitted up to receive plants.

The forcing house plant (Fig. 5) covers 5,300 square feet of ground, of which approximately 4,000 square feet is covered with glass. The plan, (Plate XIII,) shows the arrangement of these houses, and the illustration (Fig. 5,) shows the elevation as seen from the south-west. The glass houses are seven in num-

ber, included in three runs or series. The upper series is twenty by sixty feet in dimensions, and this is divided into two houses, A and B, nearly equal in extent. These are low houses, three-fourths span upon a sharp slope, and they are used for the cooler plants, such as lettuce, radishes, spinage, peas, tulips, verbenas, etc. In this house electric light experiments were carried on during last winter, and they are now under progress a second time. The central or second series is twenty by sixty feet in total outline, and is divided into two equal parts, C and D. Each part is built upon a somewhat different plan. Both are two-thirds span, being built upon a sharp slope. C has a gable standing eleven feet above the walk, while the gable of D stands nine feet high. House C is designed primarily as a tomato house, and the tomato crop which is in it at the present time is in every respect an admirable one. (Fig. 6.) House D is designed primarily as a cucumber and melon house, in which capacity it has been used last

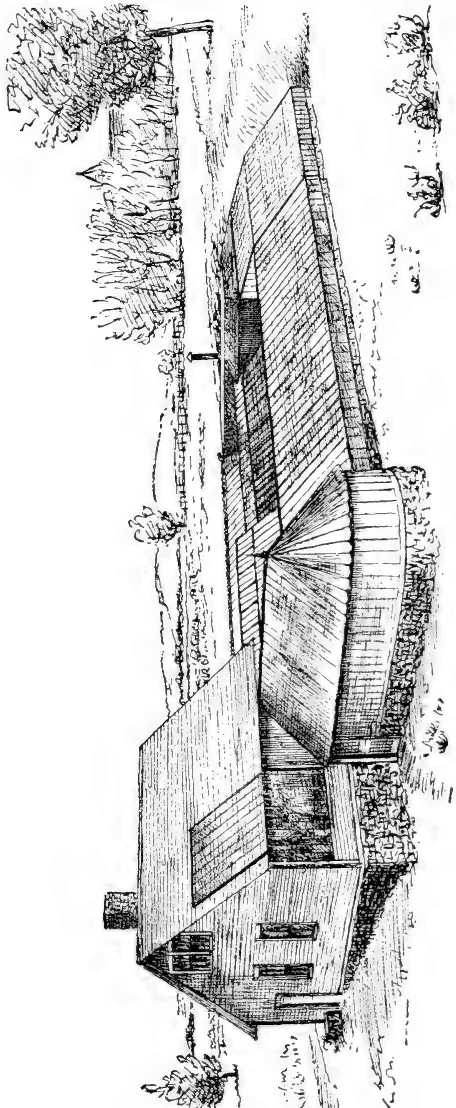


FIG. 5.—*Forcing Houses.*

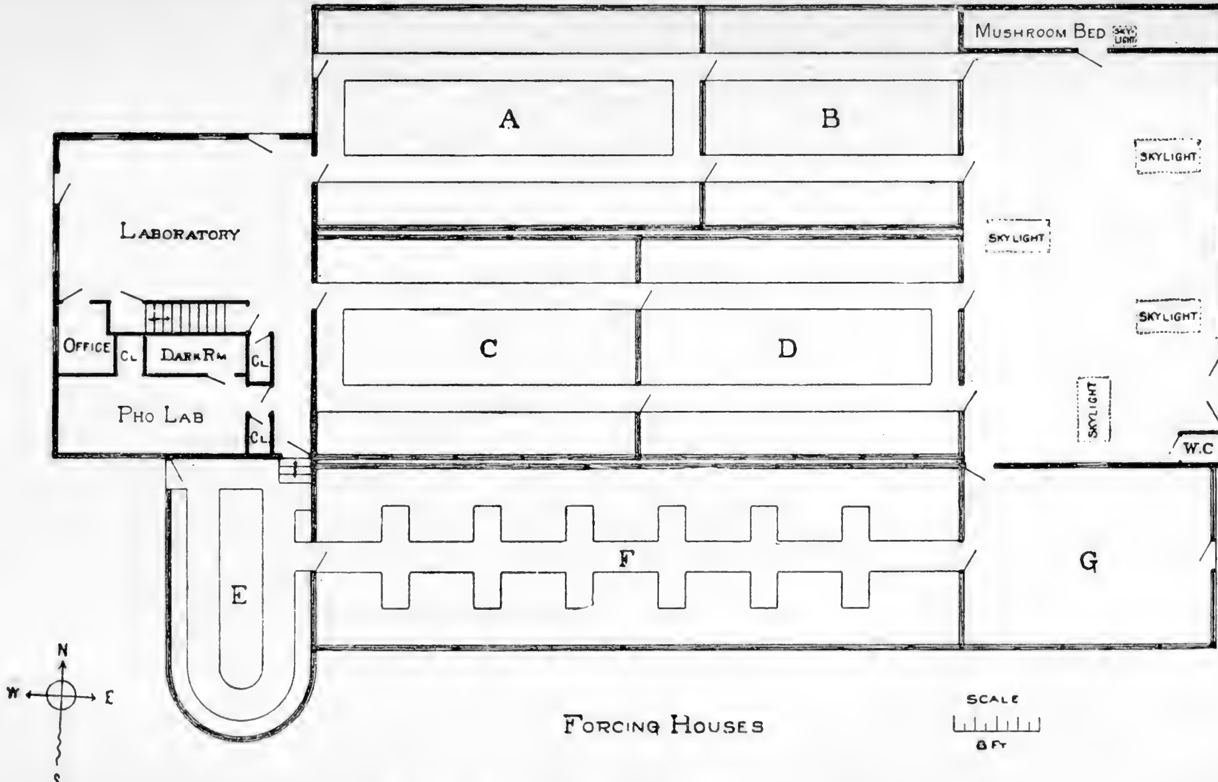


Plate XIII.—*Plan of Forcing Houses.*

winter and this, and incidentally it has been used for the growing of winter beans.

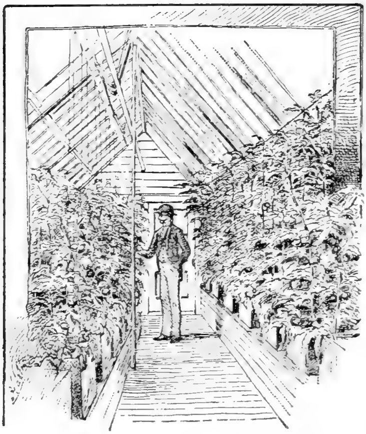


Fig. 6.—*A Tomato Walk.*

The third or lower series of houses is ninety four feet in length and is divided into three unequal parts. E is a conservatory attachment which is to be used for various ornamental plants. F is a laboratory-house, and G is a fruit-house in which it is expected to grow peaches, nectarines, grapes and other fruits. These houses are built upon level ground and are even in span. They are built entirely from the general university funds, but as they belong to the horticultural plant it may be proper to speak of them here. They are designed for the purpose of teaching horticulture, while the four houses above them are used entirely for experimental work. House F is what I consider a model laboratory-greenhouse. It is sixteen feet wide with a gable elevation of about nine feet. The tables upon the side are divided by cross walks so as to separate one student from another, and to give him a place to work where he will not interfere with others who may be passing through the house. In this house the students do work in small detachments upon the leading operations of horticulture under glass, more especially upon the more difficult kinds of propagation, upon pollination and the management of various interesting subjects. The house is now being stocked with a variety of ornamental plants for this purpose. Incidentally, much experiment will be performed in this house, but it is experiment which will have the instruction of the student for its first object. House E will form an overflow for house F, but it is designed, nevertheless, for the definite instruction of students.

All the houses are connected by two buildings which extend across their ends. Upon the front is a building, twenty-four by thirty feet, which includes a large laboratory room and small office, and a well equipped photograph gallery. Above, it comprises an attic and a sleeping room. In the basement of this

building are the heaters, two in number. This building itself, and houses A, B, C and D are heated by steam. The remainder of the plant it heated by hot water, but it is piped in the modern system, and either hot water or steam can be used as may be thought best. It is hoped that some definite observations upon the relative merits of hot water and steam, which shall be alternately generated in the same apparatus, can be undertaken here very soon. This basement also contains a mushroom cellar, which lies directly under the photographic laboratory. Across the eastern end of these houses is a low building, twenty-two by forty feet. It is a large work-room in which the potting for all the houses is done, and which contains benches and tools for steam and water fitting, a portion of the carpenter tools, etc. It also contains an engine to be used for running pot washing machines and other apparatus. Across one end of this building is another mushroom bed. Lying still to the east of this series of houses, and not shown upon the plan, is another small mushroom pit.

Various styles of construction have been employed in the building of these houses, and various kinds of glass have been used, so that together they afford an excellent test of various methods of building greenhouses. The lower series, including houses E, F, and G, is glazed without the use of putty. The roof of house F is dividen into four sections, each of which contains a different quality and thickness of glass. It is proposed to keep an account of each section during a number of years for the purpose of ascertaining what are relative amounts of breakage by hail and other agencies. In house G it is designed to test the value of other coverings than glass for forcing-houses. It now has a roof made of oiled paper, but this is a failure. We shall soon put on a roof of oiled muslin. The houses, taken together, make a remarkably compact and easily handled plant. Many different conditions of exposure, heat, sun-light, etc., can be secured, so that exceedingly various operations can be carried on in them.

Aside from this equipment, the station has a large barn sixty by eighty feet in dimensions, in which are two storage cellars, a large grafting room and tool room, a large basement, storage rooms for wagons, tools and fertilizers, and a number of stables, part of which are rented. An elevation of this barn is seen in Fig. 7.

The grounds belonging to the horticultural division, com-

prise something over twenty acres of very uneven land. Part of it is a very stiff clay, and part is a good quality of gravel and garden loam. The plantations upon this area are of considerable importance. They include a dwarf pear orchard, set last spring, of three hundred trees, a small orchard of apricots, plums, and pears, a small huckleberry plantation, about fifty varieties of apples, and a vineyard of about sixty varieties; also cherries, nine varieties; peaches, seven varieties; nectarines, almonds, mulberries, nuts, and various other tree fruits; blackberries, ten varieties; raspberries, fifteen varieties; currants, nine varieties; gooseberries, four varities; strawberries, twenty varieties; plantations of many wild fruits, including juneberries, a small but growing Prunicetum, in which it is designed to grow all the native plums of America; a Rubicetum, into which the wild brambles are being collected.

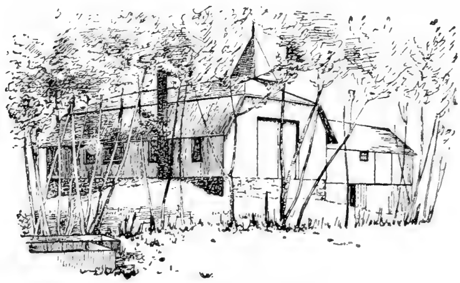


FIG. 7.—*Garden Barn.*

The horticultural division has two offices in Morrill Hall, one of which is devoted to clerical work, and the other of which contains the garden herbarium, Fig. 8. This garden herbarium is one of the most important features of the work of the division. It is growing rapidly and has even now assumed large proportions. Every variety of every species grown in the gardens is pressed and mounted. Besides this, collections are made at leading nurseries in various parts of the country and arrangements are being made by which cultivated plants of foreign countries are to be secured. In short, the scope of the garden herbarium is nothing less than an herbarium of the cultivated species and varieties of the world. This I consider an invaluable auxiliary to any complete and comprehensive study of the variation of cultivated plants. The division also own a great number charts and prints of various kinds. The library contains files of all the leading journals, both domestic and foreign, and a very large selection of the best horticultural writings. Most of the periodicals are also laid directly before the eyes of students by keeping them on file in the agricultural reading-room.

Although the experimental work of the division is varied, it nevertheless has a unity of design throughout. The variation of plants under culture is the perennial theme of investigation. The mere testing of varieties forms a small and comparatively unimportant labor. It is felt that such work is scarcely experimentation, and it would be folly to undertake it as long as means exist for undertaking work of a somewhat general and comprehensive character. Yet nearly all the novelties are grown, not so much, however, for the purpose of making definite reports upon them with the idea of establishing their merits, as for the purpose of keeping track of the kind and extent of variation in plants, and also for the purpose of answering any questions concerning them which may be submitted to us. In other words, while the novelties, or a large part of them, are grown, we do not expect to make definite reports upon them, with the exception of special cases in which we are making particular studies. We have selected a few general orders or kinds of plants upon which we are making the most careful studies. These are, at present: 1st, tomatoes; 2d, cucurbits, including the pumpkins, squashes, melons, and cucumbers; 3d, egg-plants; 4th, plums and cherries, and their allies, more especially the wild species; and 5th, the brambles, including the raspberries, blackberries, and their wild congeners. In these particular lines we expect to arrive at more or less definite conclusions concerning the novelties of any year, especially so among the garden vegetables mentioned. These plants, and all others which we grow, are studied with reference to the influence upon them of soil, culture, and climate, and especially with reference to the effects of crossing and hybridization. The crossing among cucurbits began a number of years ago. They have now reached about one thousand in number, and our our plantations of pumpkins and squashes, during the last year,

FIG. 8.—*The Garden Herbarium.*

the product of crosses and selections, comprised upwards of eight acres. The results of this labor among cucurbits have been most remarkable, and there is every indication that within a few years we shall have attained practical and scientific results of value. Crosses among egg-plants have also been considerable, and some two hundred crossed plants were grown this year with very satisfactory results. Crosses are also growing between various varieties of tomatoes. Extensive hybridizations have been made between the different species of raspberries, between raspberries and blackberries, and between blackberries and dewberries. Something over two hundred and fifty successful hybridizations were performed last year. Hybridizations were also made last year between two species of gooseberries, but unfortunately the fruits were lost. Extensive experiments are now under way to determine to what extent color can be regulated by crossing and hybridization. This work is now being prosecuted with coleus, mimulus, silene, phlox, tomatoes, and other plants. Experiments in hybridization are also progressing in many other lines.

In the winter of 1889–90, houses A and B were devoted to experiments to determine what influence the electric light has upon the growth of plants. Certain experiments have been conducted abroad upon this subject with nearly diametrically opposite results, and the statements of gardeners in this country concerning the influence of street lights upon greenhouse work and of electric lights upon flowers on exhibition, have led us to undertake this experiment, which has been prosecuted at considerable expense. House B was lighted by electricity during every night during last January, February, March, and part of April, receiving sun-light during the day time, while house A was kept under ordinary conditions. Each of the four benches running lengthwise of the house was planted continuously. Peas, endives, spinage, radishes, and lettuce were the chief subjects of the experiments, although some flowering plants were used. The results were marked in every case, so much so that it was determined to repeat the experiment during the present winter under somewhat different conditions. During last winter the electric light was run all night. We procured an engine and dynamo and made the electricity ourselves. This year we are making the test under what might be called practical conditions, by running a street lamp into the houses. This runs only half the

night. In addition to the experiment upon lettuce, peas and radishes, this winter we shall make experiments upon the influence of electric light upon color, and for this purpose we are growing named varieties of heliotrope, verbenas, tulips, petunias, coleuses, primulas, fuchsias, and some other plants. The present indications are that we shall be ready to report upon this series of experiments at the close of the winter.

An interesting field experiment which was inaugurated in the spring of 1889, which it is expected to continue indefinitely, is one to determine the influence of various fertilizers upon fruit trees and to endeavor to answer the question if fruit growing can be carried on profitably with the use of concentrated fertilizers alone. Two orchards are set aside for this purpose, each one being divided into three equal parts. One section in each receives no treatment except the ordinary cultivation. The others receive complete manures of one kind or another, and in addition each one receives an extra amount of some one fertilizer; for instance, one receives an excess of potash, another an excess of phosphoric acid, and another an excess of nitrogen. By these means we hope to be able not only to answer the question as to whether orchards can be profitably fertilized with concentrated fertilizers, but also to learn something of the controlling factors in the fertilizing of orchards. One feature of this experiment refers to the best and cheapest source of nitrogen. Upon one section the nitrogen is applied in the form of nitrate of soda, and another in the form of leguminous green manure. The orchards in which these experiments are in progress comprise dwarf and standard pears, plums and apricots. Unfortunately most of the soil is clay, and probably results will not be obtained as early as upon sandier soils.

Experiments upon the best methods of propagating plants are under progress, especially one concerning the moot point of the relative merits of budded, crown-grafted and root-grafted apple trees.

A very large part of the endeavors of the division is devoted to methods of forcing plants. We are or have been forcing the following plants: radish, endive, lettuce, spinage, pea, bean, cucumber, melon, tomato, eggplant, mushroom, cauliflower and some others. Another season we shall expect to have our houses ready for the forcing of still other plants. Our cucumber forcing experiment is

now in its second season. The primary object of this experiment to determine the facts in regard to fertilization of cucumber is flowers under glass. It is a question of considerable importance, both from a practical and scientific point of view, and no definite experiments have been made upon it. Our results are definite, and there is every reason to believe that we shall shortly be able to publish results of value. The tomato forcing experiment was under taken for several reasons, as the determination of the best methods of forcing tomatoes, the best varieties, how to control various fungi and insect attacks, and to perform experiments in cross-pollination.

Many secondary investigations are under way, of which the following may be mentioned: An experiment with the cultivation of huckleberries, both at the station and upon a piece of land in the eastern part of the state; tests of edible plants of foreign countries to determine which ones give promise in this state; tests in the automatic ventilation of green-houses, and several other features of green-house construction; a large experiment to determine the influence of food—chiefly concentrated fertilizers—upon the variation of plants; a large experiment with hardy foreign and domestic roses; a systematic study of horse-radish, with particular reference to propagation and improvement; and at all times the study of the species and the variations of plants under culture. In all our work photography is used freely as a means of preserving accurate records.

Respectfully submitted,

L. H. Bailey, Horticulturist.

APPENDIX I.

BULLETINS PUBLISHED DURING THE YEAR.

XVI—XXV.

CORNELL UNIVERSITY,

COLLEGE OF AGRICULTURE.

BULLETIN

OF THE

Agricultural Experiment Station.

AGRICULTURAL DIVISION.

XVI.

MARCH, 1890.

Growing Corn for Fodder and Ensilage.

"That art on which a thousand millions of men are dependent for their sustenance, and two hundred millions of men expend their daily toil, must be the most important of all; the parent and precursor of all other arts. In every country, then, and at every period, the investigation of the principles on which the rational practice of this art is founded, ought to have commanded the principal attention of the greatest minds."—JAMES F. W. JOHNSTON.

PUBLISHED BY THE UNIVERSITY,
ITHACA, N. Y.,
1890.

CORNELL UNIVERSITY.

Agricultural Experiment Station.

BOARD OF CONTROL:

Offices of the Director and Deputy Director, 20 Morrill Hall.

Those desiring this Bulletin sent to friends, will please send us the names of the parties.

GROWING CORN FOR FODDER AND ENSILAGE.

A TEST OF VARIETIES OF ENSILAGE CORN.

The results of most of the experimental work upon the growth of corn for ensilage have strongly indicated that those varieties that will reach a fair degree of maturity are the best for fodder and ensilage purposes. Nevertheless, the strong growing and late maturing varieties have remained favorites with many because of the large yield of green fodder obtained from them. We have grown during the past season forty-one different varieties, (including "Kaffir Corn," a sort of sorghum). These varieties include all that were advertised as valuable for ensilage purposes in the seed catalogues that were at hand. Our list of varieties grew so rapidly late in the season, that we could not give to all as much space as was intended; consequently a selection was made of fifteen of the most prominent varieties. These were planted in tenth-acre plots, so as to get the comparative yield as well as the comparative composition. The remainder were planted in single rows only, and no attempt was made to ascertain the comparative yield.

The season was late and very wet, yet the frosts held off so long in the fall that the season was fully as long as ordinary, and the different varieties reached as mature a stage as they would be likely to in an ordinary season.

The varieties that were planted in single rows were planted May 8th, but owing to the frequency and abundance of the rainfall it was impossible to plant the fifteen varieties on the tenth-acre plots until May 14th.

All the corn was planted on a clover and timothy sod. That planted in tenth acre plots received no fertilizer. That planted in sample rows was in the general corn field and had received a liberal dressing of farm-yard manure before the ground was plowed. Sibley's Pride of the North was planted in duplicate, one plot was planted with seed procured from H. Sibley & Co., and a single row was planted from seed that had been grown at the Station for several years.

Vegetation was rapid and even, with the exception of the Evergreen Sugar and the Sibley's Pride of the North from Sibley & Co. In these cases scarcely more than half a stand was obtained, thus in great measure accounting for the small yield from these two plats. That all the varieties might have the utmost chance for development, as the season for frost approached the state of the weather was narrowly watched and cutting delayed as long as possible. On Sept. 18th it was thought that it would not do to delay cutting longer, accordingly the varieties were sampled as follows. While the corn was still standing, from each variety an average hill of three stalks was selected and carefully cut close to the ground. It was then securely tied and taken to an upper chamber in the barn where it was left until dry enough to run through a coarse coffee mill. The whole hill was then ground and from this ground material a sample was taken for analysis.

At the time of cutting the different varieties were in the following stages of ripeness :

Four had passed the best stage of maturity for preserving as ensilage, viz.: Compton's Early, King Philip, Self Husking, Suffern's Monarch Pop.

Twelve were in the best condition for cutting, *i. e.*, well glazed but with the stalks still green. These were: Chester County Mammoth, Golden Dewdrop, King of the Earlies, Longfellow, N. B. & G. Yellow Dent, Pride of the North (C. U. seed), Pride of the North (Sibley seed), Sanford, White Dent, White Flint, Yellow Cleavage, Yellow Flint.

The remainder, with the exception of the Brazilian Flour Corn, which was very immature, were in various stages of the roasting ear condition. None were mature enough for best results, though a few approached this condition, and perhaps in a warmer and dryer season would have become mature. In the table below is given the percentage composition of the green forage as it stood Sept. 18. The varieties set in bold faced type are those that were planted in tenth-acre plots and are treated more in detail further on. In the second column the letters indicate the class, as y. d., Yellow Dent; w. f., White Flint; s., Sweet, etc. The varieties are arranged in the order of their percentage of dry matter, and while the other constituents vary somewhat, it will be seen that with a few notable exceptions the variation in the percentage of water constitutes the main difference in composi-

tion. In the last column under the heading "Nutritive Ratio," is shown the relation between the nitrogenous and non-nitrogenous constituents in the same way that is usual, except that here the whole of the nutrients instead of merely the digestible portions are compared.

TABLE I.

VARIETY.	Kind.	Water—per cent.	Dry Matter—per cent.	Protein—per ct.	Fat—per cent.	N.-Free Extract. Per cent.	Fibre—per cent.	Ash—per cent.	Nutritive Ratio. As 1 to
1. N. B. G. Yellow Dent	y. d.	63.03	36.97	2.52	1.10	23.92	7.73	1.70	13.7
2. Pride of the North, C. U.	y. d.	65.12	34.88	2.19	1.20	22.45	7.38	1.66	15.0
3. King of the Earlies	y. d.	68.47	31.53	2.50	.84	19.84	7.01	1.34	11.6
4. Self-Husking	b. f.	69.68	30.32	2.52	1.45	16.35	7.84	2.16	11.0
5. Yellow Cleavage	y. d.	70.54	29.46	1.95	.65	17.67	7.82	1.37	13.9
6. King Philip	b. f.	71.02	28.98	2.21	.89	18.14	6.30	1.44	12.1
7. **Sanford**	w. f.	71.95	28.05	2.37	.80	16.80	6.31	1.77	10.6
8. Compton's Early	y. f.	72.85	27.15	2.16	.84	15.02	7.57	1.56	11.9
9. Golden Dewdrop	y. d.	72.95	27.05	2.30	.85	16.22	[illegible].23	1.45	10.7
10. Longfellow	y. f.	73.86	26.14	2.09	.78	14.14	7.54	1.59	11.3
11. Queen of the Prairie	y. d.	74.05	25.95	1.94	.69	15.92	6.04	1.36	12.2
12. Early Mastodon	y. d.	74.20	25.80	2.05	.77	16.80	4.77	1.41	11.5
13. **Early White Dawn**	w.d.	74.43	25.47	1.41	.43	14.26	8.20	1.17	16.7
14. **Pride of North**, Sib.	y. d.	75.84	24.16	1.84	.93	11.82	8.31	1.26	12.2
15. Kaffir Corn (sorgh)	. .	76.05	23.95	2.34	.41	11.40	8.36	1.44	8.9
16. **Leaming**	y. d.	76.21	23.79	1.41	.47	13.87	6.98	1.06	15.6
17. **Mam. W. Surprise**	w.d.	76.44	23.56	1.94	.47	13.42	6.57	1.16	10.9
18. Yellow Flint	y. f.	76.45	23.55	1.88	.35	14.32	5.23	1.77	10.9
19. Champion W. Pearl	w.d.	76.50	23.50	1.06	.42	14.73	6.03	1.26	20.6
20. White Flint	w. f.	76.93	23.07	1.80	.64	13.15	5.86	1.62	11.5
21. Chester Co. Mammoth	y. d.	77.02	22.98	1.71	.41	13.64	5.88	1.34	12.0
22. **Big Buckeye**	y. d.	77.17	22.83	1.03	.37	11.68	8.73	1.02	20.7
23. White Dent	w.d.	77.42	22.58	1.66	.49	15.92	3.47	1.04	12.4
24. Hickory King	w.d.	77.59	22.41	1.79	.45	13.45	5.65	1.07	11.3
25. Golden Beauty	y. d.	77.90	22.10	1.80	.25	13.77	5.20	1.08	10.9
26. **B. and W.**	w.d.	77.98	22.02	1.18	.35	12.76	6.54	1.19	17.1
27. Sweet Fodder	s.	78.38	21.62	1.73	.76	12.24	5.53	1.36	11.4
28. **White Southern**	w.d.	78.52	21.48	1.58	.33	9.98	8.55	1.04	12.3
29. **Genuine Sou**	w.d.	78.54	21.46	1.44	.86	11.42	6.50	1.24	13.9
30. **Breck's Bost. M'kt**	w.d.	78.83	21.17	1.66	.36	11.13	6.77	1.25	11.3
31. Sufferns Monarch Pop	p.	78.93	21.07	1.67	.44	10.21	7.50	1.25	11.3
32. Ensilage or Fodder	w.d.	79.36	20.64	1.65	.56	10.93	6.44	1.06	11.4
33. **Blount's Prolific**	w.d.	80.39	19.61	1.49	.30	9.45	7.41	.96	11.8
34. Livingston's Gold Coin	s.	80.44	19.56	1.65	.66	11.79	4.39	1.07	10.8
35. **Red Cob Ensilage**	w.d.	80.45	19.55	1.33	.93	10.62	5.66	1.01	14.0
36. **Acme Everg. Sweet**	s.	80.95	19.05	1.29	.52	11.17	5.08	.99	13.6
37. Farmers' Favorite	y. d.	81.42	18.58	1.50	.63	10.95	4.46	1.04	11.3
38. Mammoth Sweet	s.	82.09	17.91	1.22	.31	10.85	4.58	.95	13.3
39. Egyptian Sweet	s.	82.54	17.46	1.33	.44	10.81	4.09	.79	12.0
40. **Flour Corn** (soft)	w.	82.56	17.44	1.13	.30	9.27	5.87	.87	14.1
41. **Evergreen Sugar**	s.	82.58	17.42	1.75	.52	10.26	3.84	1.05	8.8

By combining the various classes, as in the table below, the differences in the composition are more clearly brought out. It will be seen that of the three classes, Dent, Flint, and Sweet, the Flints have the largest percentage of dry matter and the Sweets the least; the Sweets have a slightly higher ratio of protein matter. The Dents have somewhat more water than the Flints and considerably less protein, but in general they give a much larger amount per acre both of green forage and dry matter, as will be seen by reference to Table III. It is interesting to note that the Kaffir Corn, with a moderate amount of water, has a much higher proportion of protein than any of the three classes mentioned. It did not, however, make a large growth of green fodder. All things considered, it seems to us that that variety of Dent corn that will approach fairly well toward maturity, in ordinary seasons in the locality, is the best for ensilage purposes.

TABLE II.

COMPOSITION OF THE DIFFERENT CLASSES.

	No. of Varieties.	Water Per ct.	Dry Matter. Per ct.	Protein. Per ct.	Fat. Per ct.	N-free Extract. Per ct.	Fibre. Per ct.	Ash. Per ct.	Nutritive Ratio. As 1 to
Dent	25	75.62	24.38	1.72	.60	14.27	6.57	1.22	12.8
Flint	7	73.25	26.75	2.15	.82	15.42	6.66	1.70	11.7
Sweet	6	81.16	18.84	1.50	.53	11.18	4.59	1.04	11.4
Pop	1	78.93	21.07	1.67	.44	10.21	7.50	1.25	11.3
Soft	1	82.56	17.44	1.13	.30	9.27	5.87	.87	14.1
Kaffir Corn . .	1	76.05	23.95	2.34	.41	11.40	8.36	1.44	8.9

In Table III is given the yield in pounds per acre of the green forage, the dry matter, and the several nutritive constituents of all the varieties planted in tenth-acre plots. The varieties are arranged in the order of the dry matter per acre produced. The numbers at the left refer to the numbers in Table I. It will be seen that there is no relation between the amount of green forage and the amount of dry matter. Though the very immature Brazilian Flour corn from its immense growth did produce the greatest amount of dry matter, there were four varieties

that produced more protein and six varieties that produced more fat.

It will be remembered that the small yield of the last two varieties was due to poor seed, there not being more than half a stand of either. If the yield of these two varieties be multiplied by two, they would stand first and thirteenth respectively.

For the sake of comparison, we have added at the bottom, the yield of the various constituents from a measured acre of Pride of the North in the general corn field. It is true that this corn was fertilized, but not all the difference may be ascribed to fertility, for the soil of the plots was fertile though not manured this year. It seems to us that most of the difference must be due to selection and acclimation of the seed through several years.

TABLE III.

VARIETY.	Yield in Pounds per Acre.								Stage of Growth.
	Green Forage.	Per ct. Water.	Dry Matter.	Protein.	Fat.	N.-Free Extract.	Fibre.	Ash.	
40. Flour Corn	44260	82.56	**7720**	498	132	4106	2598	386	Barely in Milk.
29. Genuine Sou.	34440	78.54	**7390**	497	298	3932	2237	426	"Roasting Ear."
28. White South'n	34060	78.52	**7320**	540	112	3399	2912	357	Milk.
17. Mammoth W. Surprise	30010	76.44	**7070**	582	142	4027	1970	349	"Roasting Ear."
33. Blount's Prolific	35340	80.39	**6934**	529	107	3340	2620	338	Milk.
30. Breck's Boston Market	31400	78.83	**6648**	523	113	3493	2128	391	Milk.
26. B. and W.	29900	77.98	**6583**	352	104	3817	1956	354	Barely in Milk.
35. Red Cob Ensilage	32660	80.45	**6383**	434	304	3466	1850	329	Milk.
16. Leaming	26800	76.21	**6375**	376	124	3720	1872	283	"Roasting Ear."
13. Early White Dawn	24200	74.43	**6162**	341	105	3449	1985	282	Milk.
22. Big Buckeye.	25740	77.17	**5876**	266	94	3005	2248	263	"Roasting Ear."
7. Sanford	19840	71.95	**5565**	469	158	3335	1252	351	Mature.
36. Acme Ever'gn Sweet	25640	80.95	**4886**	330	134	2863	1304	255	"Roasting Ear."
14. Pride of the North (Sib.)	16980	75.84	**4102**	313	158	2007	1410	214	Mature.
41. Everg'n Sugar.	16360	82.58	**2850**	287	86	1678	628	171	"Roasting Ear."
*Pride of the North.	30108	69.75	**9109**	686	224	5598	2282	319	Mature.

* On a measured manured acre from the general corn field.

On the following pages the results of Table III are shown in diagrammatic form, the black lines representing the water and the colored the various other constituents. In order to make the differences clearer the colored plate is enlarged five times, or in other words each inch in length of the black lines represents a yield of 6,000 pounds of water per acre, and each inch in length on the colored plate represents a yield of 1,200 pounds of the other constituents per acre. The figures refer to the numbers in Table I.

It seems still necessary that an explanation of the terms used should accompany all discussions of foods and fodders, and we may therefore be pardoned for repeating it here.

The value of a fodder in the main depends upon the amount and relative proportions of four classes of constituents. These are usually denominated by chemists as crude protein (nitrogen multiplied by 6.25), ether extract, nitrogen-free extract, and fibre, and on the accompanying plate are represented by red, yellow, blue, and golden brown, respectively.

Protein is the most costly and the most valuable constituent of fodders. Protein substances contain nitrogen and are often called albumenoids or flesh formers. They are found in all parts of all plants and all animals, and are important and indispensable constituents of lean meat, blood, and all internal organs. Since a large number of fodders are lacking in this class of constituents, the amount of protein that a fodder contains is largely a measure of its value.

Ether Extract is mainly composed of fats and oils, and is usually spoken of as such. It is used by the animal as a heat producer or stored up in the tissues of the body as surplus fat. For these purposes it is worth nearly two and one-half times as much as starch, sugar, gum, and other carbhydrates.

Nitrogen-Free Extract consists of those substances containing no nitrogen that are soluble in water and dilute acids and alkalies, it is mainly made up of starch, sugar, and gum, and the whole class is often spoken of as carbhydrates. The function of these carbhydrates in the animal economy is mainly that of heat and fat producers.

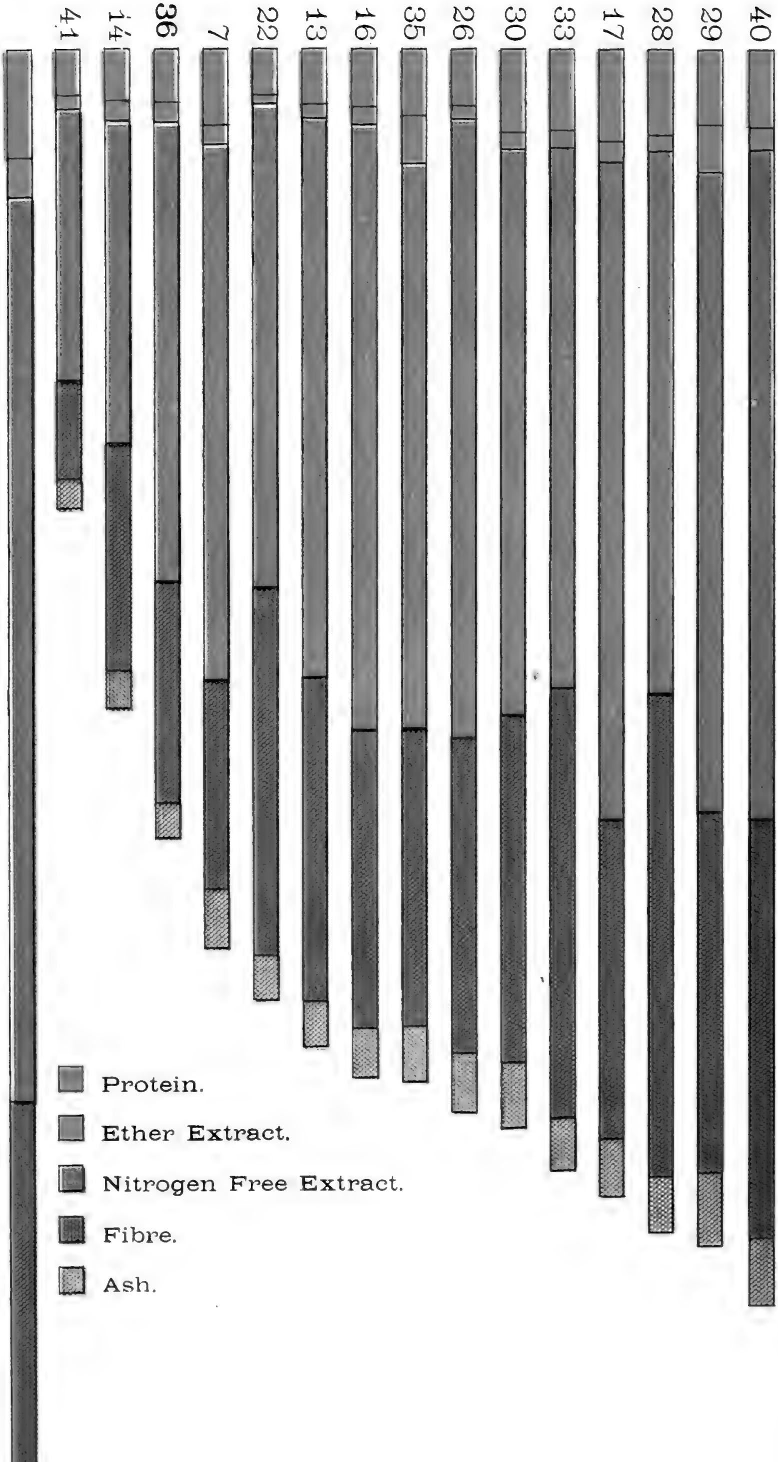
Fibre is that portion of the plant not dissolved by the action of dilute acids and alkalies. In composition it is a carbhydrate, and its function as a fodder is the same as the other carbhydrates, but being less digestible is of less value.

The *Nutritive Ratio* is the ratio of the protein to the other three classes. It is always expressed by the formula "as 1 : —" It is found by adding to the digestible portion of the fibre and nitrogen-free extract two and one-half times the digestible fat, and dividing the sum by the digestible protein. For example, one hundred pounds of clover hay contain 7.82 pounds of digestible protein ; 40.25 pounds of digestible nitrogen-free extract and fibre, and 1.49 pounds of digestible fat. Two and one-half times 1.49 is 3.72, this added to 40.25 makes 43.98. and this divided by 7.82 gives 5.6. Clover hay, then, contains one part of protein to five and six tenths parts of nitrogen-free extract, fat and fibre, or as it is expressed, the nutritive ratio of clover hay is 1 : 5.6.

As to the money value of the various constituents the Germans have estimated that disgestible protein and fat are each worth four and one-third cents per pound, and that digestible carbhydrates are worth nine-tenths of a cent per pound. These figures are much too high for American fodders, especially for protein.

Dr. Jenkins, (Ct. Exp. Station Bull., 96), has made an estimate, based on the selling price of various concentrated foods, that protein is worth 1.6 cents, fat 4.2 cents, and carbhydrates .96 cents per pound. On this basis, not including the fibre, the fodder produced on an acre of our field corn (last line of Table III, and right hand figure of plates) would be worth $74.13, while the fodder produced on an acre of Evergreen Sugar (No. 41 of Table III and plates) would be worth $24.31. These figures are evidently too high for coarse fodders, yet they serve to show the relative value of different varieties.

In regard to the ash it is only necessary to state that while it is an indispensable constituent of foods, almost all fodders contain a sufficient amount and it may therefore be ignored in discussing them.



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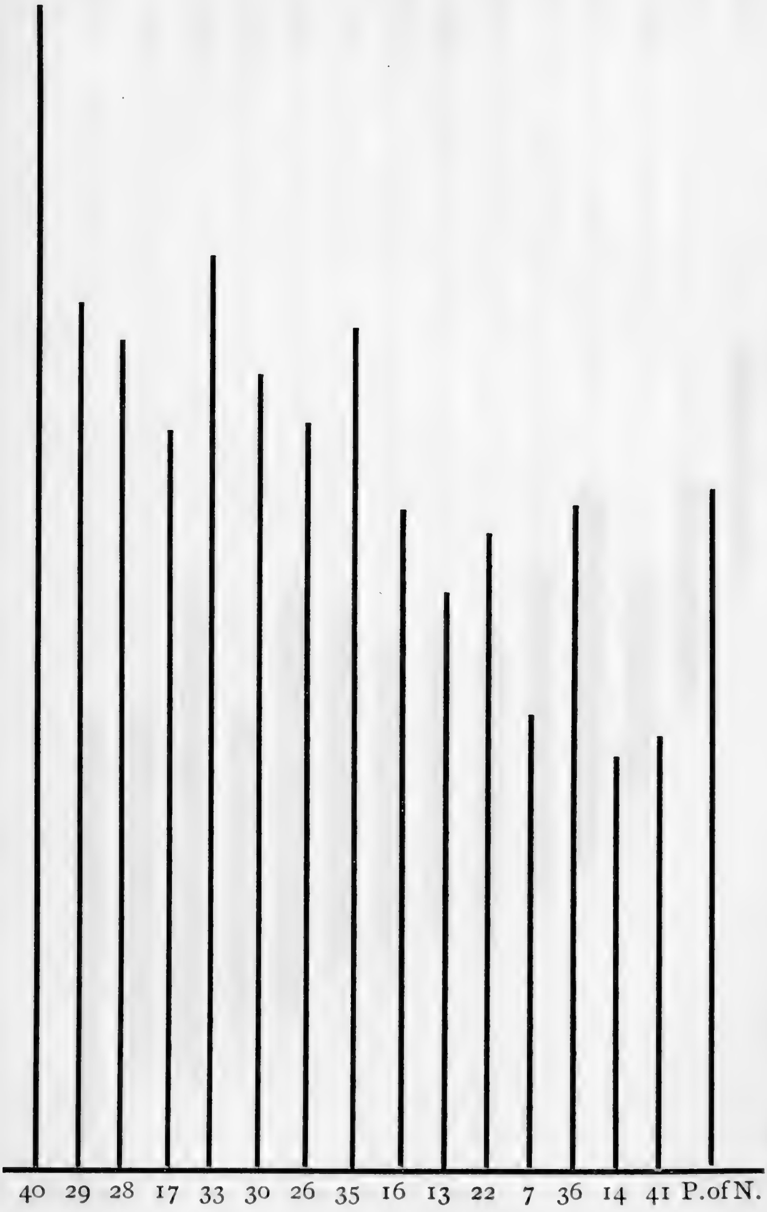
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THE BEST PERIOD FOR CUTTING.

As the results of analyses made at different periods of growth in 1888 we strongly urged* that only such varieties of corn should be grown for ensilage as would reach a good degree of maturity in the locality grown. These conclusions have been abundantly confirmed, not only by our own experiments repeated in 1889, but by similar experiments at several other stations.

The variety used was the same as last year, viz: Pride of the North of a strain that has been grown on the farm for several years and has become well acclimated. The soil was a clayey loam. It was in clover and timothy sod and had received a good dressing of farm-yard manure during the winter. The corn was planted in hills three feet three inches by three feet eight inches apart, and received ordinary cultivation.

The season was late and very wet. The corn was planted about May 12, and the first cutting was made on August 2, at which time it was just coming into blossom and was at the same degree of maturity, as well as could be judged, that it was in 1888 on July 24th. On Aug. 17th the second cutting was made, the kernels were just beginning to fill with milk. The corn matured much more slowly in 1888 than in 1889, and further cuttings were made on Aug. 31st and Sept. 10th, during the period of "roasting ear" condition, The final cutting of the mature corn was made on Sept. 24th, no frost having intervened. The corn at this cutting was perhaps a trifle more mature than it was in 1888 on Sept. 3.

The samples were taken as follows: At each cutting three average hills were selected and cut close to the ground. They were then treated in the same manner as the samples of the different varieties already described. The table below shows the percentage composition at the various periods. It will be noticed that the most marked difference is in the great increase in dry substance between Sept. 10th and Sept. 24th. It will also be noticed that there was more water on Aug. 17th than on Aug. 2d. This is entirely out of the usual experience and may perhaps be due to the individuality of the plants sampled. In regard to the dry substance we find, as is usual, that the per cent. of protein gradu-

* BULLETIN NO. IV, Cornell University Agricultural Experiment Station, p. 52.

ally diminishes and the carbhydrates and fibre increases as development approaches maturity.

TABLE IV.

Date of Cutting.	Stage of Maturity.	Water Per Cent.	Dry Matter Per Cent.	In the Dry Matter.				
				Crude Protein Per Cent.	Ether Extract (fat) Per Cent.	Nitro. Free Extract (carbhydrates) Per Cent.	Crude Fibre Per Cent.	Ash Per Cent.
Aug. 2 . . .	In Bloom.	85.25	14.75	9.87	2.68	58.07	22.06	7.32
Aug. 17 . .	In Milk.	87.31	13.69	9.03	1.71	57.74	25.11	6.41
Aug. 31 . .	Roasting Ear.	82.56	17.44	8.84	1.96	55.21	28.43	5.56
Sept. 10 . .	Roasting Ear.	81.37	18 63	6.17	2.43	59.06	27.19	5.15
Sept. 24 . .	Mature.	69.75	30.25	7.53	2.46	61.46	25 05	3.50

At each period of cutting, except the last, besides taking the sample, there were cut and weighed sixty hills of corn. The weight of the corn so cut was used as a basis for computing the yield of green fodder and of the various constituents per acre, except in the cutting of Sept. 24, when a measured acre was cut and weighed. These results are shown in the table below.

TABLE V.

Date of Cutting.	Stage of Maturity.	Yield in Pounds Per Acre.							
		Green Forage.	Per Cent. Water.	Dry Matter.	Crude Protein.	Ether Extract.	Nitrogen Free Extract.	Crude Fibre.	Ash.
Aug. 2	In Bloom.	24805	85.25	3658	361	98	2124	807	268
Aug. 17 . . .	In Milk.	27830	87.31	3810	344	65	2200	957	244
Aug. 31 . . .	Roasting Ear.	30250	82.56	5274	467	103	2912	1499	293
Sept. 10 . . .	Roasting Ear.	28980	81.37	5398	333	133	3188	1466	278
Sept. 24 . . .	Mature.	30108	69.75	9109	686	224	5598	2282	319

It will be seen that between the first and last cutting the dry matter and carbhydrates increased about 150 per cent., the fat about 125 per cent., and the protein nearly doubled. In our experiments last year* we found that the total feeding value, in the period between tasseling and ripening, increased 166 per cent., so that the experiments of this year confirm those of last.

Further than this, investigations at three other experiment stations have been made in almost exactly the same way and the results of all agree. These experiments in brief are as follows:

In 1887 Professor Whitcher, of the New Hampshire Agricultural Experiment Station, made analyses of four different varieties at four stages of growth.† The four varieties were a southern ensilage corn, a northern flint corn, Sanford (flint), and Pride of the North (dent). The cuttings were made July 26, Aug. 5, Aug. 19, and Sept. 16. At the first date none were in tassel but the northern flint; at the last date the northern flint was completely ripe, the Sanford and Pride of the North were nearly mature, and the kernels of the southern ensilage were just blistering. Between Aug. 5th, at which time but one of the varieties had passed the blossoming stage, and Sept. 16th, there was an increase in dry matter of 112 per cent., in albumenoids of 50 per cent., in fat of 84 per cent., and in carbhydrates of 130 per cent.

In 1888, at the Pennsylvania Agricultural Experiment Station, Mr. Caldwell found‡ that between the period of tasseling and complete ripeness there was an average gain of dry matter of 155 per cent. Ten varieties of corn (dents and southern ensilage corn) were used. Only the dry matter was determined. The dates of cutting are not given, and the last determination was made from the ears and stover cut and shocked as for grain.

In 1889, at the New York Agricultural Experiment Station, a very thorough investigation of this subject was made by Mr. Ladd, chemist of the station.|| The variety used was King Philip; the dates of cutting were July 30, Aug. 9, Aug. 21, Sept. 7, and Sept. 23, at which dates the condition of maturity was, respectively, tasseled, silked, in milk, glazed, and ripe. The computations were in each case based on the yield of a plot of a fifth of an acre so taken as to represent the average of a field of twelve

* Cornell University Agricultural Experiment Station BULL. IV, p. 52.
† New Hampshire Agricultural Experiment Station Bull. No. 3.
‡ Pennsylvania Agricultural Experiment Station Bull. 7, p. 7.
|| New York Agricultural Experiment Station 8th Ann. Rept., p. 86.

TABLE VI.

Year.	Place.	Variety.	Stage of Maturity.		Date.		Gain in per cent. between first and last cutting.			
			First Cutting.	Last Cutting.	First Cutting	Last Cutting	Dry Matter.	Albumenoids.	Fat.	Carbhydrates.
1889	Cornell Ag. Exp. Sta.	Pride of the North.	Bloom . .	Mature	Aug. 2	Sept. 24	150	90	129	169
1888	" " "	" "	Bloom . .	Nearly Mature. .	July 24	Sept. 3	217	134	374	300
1889	N. Y. Agr. Exp. Sta.	King Philip. . . .	Tasseled .	Ripe	July 30	Sept. 23	389	183	335	462
1887	N. H. " "	Av. 4 Vars.	*Tasseled.	*Glazed	Aug. 5	Sept. 16	112	50	84	130
1888	Pa. " "	Av. 10 Vars. . . .	†Tasseled.	†Ripe and Cured.	. . .	. . . .	155	. . .	. . .	. . .
	Average of all Trials						**205**	**114**	**230**	**265**

* The average condition of the four, as near as may be. † The actual condition of each, dates not given.

acres. Between the first and last period there was an increase in dry matter of 389 per cent., of albumenoids of 183 per cent., of fat of 335 per cent., and of carbhydrates of 462 per cent.

In the above only the gain between the first and last periods is given, but the details show that the gain is continuous from period to period, and in general most rapid toward the last.

The results of all these experiments unite to show that there is a large increase of all the classes of nutrients as the corn proceeds from tasseling to ripeness. This is perhaps more clearly shown in Table VI on page 13, in which all the results have been grouped.

It would seem as though the question of the proper time to cut corn for ensilage was definitely settled by these experiments. An increase of more than two hundred per cent. between the periods of bloom and ripening cannot be ignored even though the proportion of the more valuable albumenoids is somewhat lessened. What gives the matter additional strength is that these experiments, including all the work so far done in this direction that has come to our notice, are unanimous in their conclusions.

SUMMARY.

Not all the points given below are based upon the experiments just detailed. Some are drawn from work done elsewhere and some from unpublished results of our own.

First, we wish to emphatically repeat our recommendation of last year, that, in growing corn for ensilage, care should be taken to select the largest variety that will fully mature before frost in the locality where grown.

Special attention is called to the fact that heretofore it has been a common practice to sow or plant corn for fodder and ensilaging, entirely too thick. Starch and sugar are not fully developed without an abundance of sunlight.

Immature plants are likely to contain a very large per cent. of water. It will readily be seen that twenty-five tons of green corn containing 90 per cent. of water, gives but five thousand pounds of dry matter ; while twelve tons containing 75 per cent. of water gives six thousand pounds of dry matter. In the latter case we get a thousand pounds more dry matter, and have to handle and store less than half the weight of gross material ;

while the corn will still have sufficient moisture to give the resulting silage that succulence upon which its value for feeding as compared with dry forage, largely depends.

While the percentage of nitrogen grows less as the plant approaches maturity, a much larger proportion of the nitrogen in the unripe material is in the less valuable form of amides, than in the mature plant. So that the less percentage of nitrogen in the riper product is compensated for in its increased nutritive value.

So far all the experiments go to show that the effort should be made to raise the largest yield of grain irrespective of stalks, no matter what purpose it is intended for. If one variety gives an equal yield of grain and a greater amount of stalks and blades, then of course it should be preferred, for fodder and ensilage purposes, to the variety that gives the less stalk and blade; but it will be found that as a rule the larger the yield of grain, the larger will be the yield of stover.

Finally, the fact should not be lost sight of, that wood and water alone, are not good foods for animals, and that they are expensive products to handle.

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HENRY H. WING.

CORNELL UNIVERSITY,

COLLEGE OF AGRICULTURE.

BULLETIN

OF THE

Agricultural Experiment Station.

CHEMICAL DIVISION.

XVII.

MAY, 1890.

A Description of Cochran's Method for the Determination of Fat in Milk, for the Use of Dairymen.

"That art on which a thousand millions of men are dependent for their sustenance, and two hundred millions of men expend their daily toil, must be the most important of all; the parent and precursor of all other arts. In every country, then, and at every period, the investigation of the principles on which the rational practice of this art is founded, ought to have commanded the principal attention of the greatest minds."—JAMES F. W. JOHNSTON

PUBLISHED BY THE UNIVERSITY
ITHACA, N. Y.,
1890

CORNELL UNIVERSITY.

Agricultural Experiment Station.

Offices of the Director and Deputy Director, 20 Morrill Hall.

Those desiring this Bulletin sent to friends, will please send us the names of the parties.

A DESCRIPTION OF COCHRAN'S METHOD FOR THE DETERMINATION OF FAT IN MILK.

FOR THE USE OF DAIRYMEN.

SEVERAL methods for the determination of fat in milk, of such a character that they can be carried out without special acquaintance with chemical manipulation, have been described recently in Experiment Station bulletins and chemical journals. All of them depend upon the same general principle—a partial decomposition or solution of some of the constituents of the milk by heating it with acid or alkali, and in most cases taking up the separated fat by ether or gasolene ; in one method, (Patrick's), no ether or gasolene is used, and in so far this method has the advantage over all others.

These methods differ in respect to the simplicity of the special apparatus required, and of the manipulation. In respect to accuracy, they are about the same as shown by the results of a number of comparative tests of them recently made in this laboratory, and exhibited in the following table. The tests of Patrick's method were made by Mr. W. P. Cutter, of the Experiment Station, the others by Mr. N. E. Wilson, of the University. The figures show the per cent. of fat found.

The description of the several methods can be found as follows :

The method of F. G. Short, Annual Report, Wisconsin Experiment Station, 1888.

The method of C. L. Parsons, Journal of Analytical Chemistry, III., 273.

The method of Professors Failyer and Willard, Journal of Analytical Chemistry, III., 295.

The method of Professor G. E. Patrick, Bulletin 8, Iowa Experiment Station, 1890.

The method of Mr. C. B. Cochran, Journal of Analytical Chemistry, III., 381.

Kind of Sample.	Gravi-metric.	Short.	Cochran.	Failyer and Willard.	Parsons.
Herd, ...	4.32	4.40	4.32	4.35	4.25
Herd, ...	4.34	4.40	4.32	4.53	4.29
Individual, . . .	4.07	4.20	4.15	4.35	3.99
Market, ...	1.63	1.50	1.55	1.48	1.31
Market, ...	4.82	5.10	5.01	5.00	4.68
Individual, . . .	3.76	3.70	3.80	4.26	3.47
" . . .	3.59	3.65	3.63	3.91	3.64
Colostrum, . . .	4.87	4.90	4.67	4.61	4.87
Individual Cow,	3.96	3.90	3.92	3.88	3.81
" "	4.81	5.00	4.84	. . .	4.74
" "	4.21	4.06	4.15	4.35	4.17
" "	2.83	2.65	2.73	. . .	2.42
" "	5.60	5.70	5.53	5.45	5.36
" "	5.66	5.60	5.70	. . .	5.33
" "	3.80	3.85	3.80	3.70	3.68

At the time that the foregoing tests were made, we were not able to get the proper form of apparatus for Professor Patrick's method. A test of that was made, later, by Mr. Cutter, with following results, comparing it both with the gravimetric method and Mr. Cochran's; the apparatus was received from Professor Patrick himself.

	Gravi-metric.	Patrick's.	Cochran's.
1	3.03	3.1	3.04
2	4.19	4.1	4.15
3	4.96	5.	5.01
4	3.42	3.5	3.46

These last results show what can be done with methods of this kind in the hands of a very experienced analyst. All the determinations were done in duplicate, and some were repeated three or four times; the results thus obtained were in most cases identically the same. All the figures given in both tables are the averages of these repeated determinations where there was any difference to be averaged. The gravimetric method followed was Dr. Babcock's asbestos method.* It was intended to use Adams' paper coil method, but suitable paper could not be conveniently obtained in season.

* Report N. Y. State Experiment Station, 1883, pp. 166 and 169.

The particular object of these tests was to determine which of these methods could be specially recommended to the dairymen of this State, for accuracy, simplicity of the apparatus required, and ease of manipulation. Since, as already shown, they do not differ essentially in accuracy, the selection of the method to be recommended must be based on the two other points. All things considered, Cochran's method seems to be clearly preferable to the others, in these two respects. A full working description of that method is therefore given, essentially as by the author himself in the original article, although in some parts with much more fullness in detail, so that with proper care in following directions no one need go amiss.

The apparatus required:

1. The fat-measure, fig. 1, a flask with a graduated tube, *b c*, and a side tube *a*.

Fig. 1.

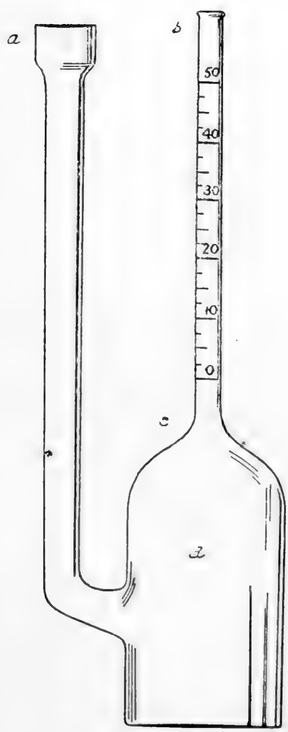

Fig. 2.

2. A boiling flask, fig. 2, known to chemists as a 100 c.c. (cubic centimeter) Erlenmeyer flask.

3. Two small measuring tubes, one with a mark on its side indicating a volume up to that mark of 2½ c.c., and the other with a mark at 4 c.c. capacity.

4. A pipette, of glass, consisting of a short, wide, glass tube terminating in two long, narrower tubes, and with a mark on the upper one of these narrow tubes indicating a capacity of 5 c.c. Mr. Cochran, in his original paper, suggests the use, in place of this, where rapid work is desired, of a little nickel dipper, holding when full just 5 c.c.; but the difficulty of emptying the milk from this into the boiling flask without loss, and without getting any of it on the neck of the flask where it would not be reached by the chemicals with which it is to be treated, seems to me so great, that till I shall have been able to try such a method of measuring, and thus to learn how large an error is likely to be introduced, I prefer to recommend the pipette.

5. A copper boiling vessel or water bath. This may be circular or oblong, and of any size desired, and about four inches in depth; a false bottom perforated with a number of small holes is soldered in, about two and a half inches from the bottom; the top, which is soldered on, has two and a quarter inch circular openings, which may be about a quarter of an inch apart. If the dish is circular, and nine inches in diameter, eight of these openings can be put in, one of them being in the center. This boiling vessel may be heated on an ordinary stove, or a small oil stove, instead of the gas burner that would naturally be used in the chemical laboratory.

The chemicals required are:

1. Commercial sulphuric acid, of good quality. Great care must be taken not to get even a drop of it on the hands or clothing.

2. Acetic acid, full strength.

3. Ordinary washed ether. Great care should be taken not to pour this from the can containing it *while near a flame of any kind*, and to keep the can *always* well stopped.

A pound of each of these will suffice for about two hundred analyses.

A set of this apparatus, with this supply of chemicals, and including six fat measures and six boiling flasks, will cost about $7.00: with half as many fat measures and boiling flasks, about

$4.00. This does not include the stove, or the boiling vessel, both of which can be purchased near at hand.

The Sampling of the Milk :—

The temperature of the milk when the sample is taken out should be about 60° F., and should not vary more than 10 degrees either way from this point ; the entire contents of the can should be well mixed together ; too much attention cannot be paid to this matter ; even when the milk is being shaken up so much as it is on the way to the factory, supposing the analyses are to be made there, the cream is rising somewhat.

If the pipette is not dry within, dip the point into the milk, suck at the upper, open end till the milk rises above the 5 c.c. mark on the stem ; blow the milk out, and repeat this operation ; then, what adheres to the inside is simply some of the milk that is to be analysed, and not water. Now fill the pipette again, holding it in the right hand, and taking hold of the upper stem, or slender part, with the thumb and second and third fingers ; remove it from the mouth, and immediately clap the ball of the index finger over the opening ; this must be done so quickly that the milk will not have time to fall below the mark on the neck ; if the first attempt is a failure, try again. Then, while facing a window, hold the pipette up so that the mark on the neck is on a level with the eye, and, raising just a little the outer edge of the ball of the finger that closes the opening, allow milk to drop out very slowly, till the level falls just to the mark ; then let the milk flow out as fast as it will with the upper opening entirely open, into the boiling flask, which should be right at hand and ready for use ; do not hurry the flow of the milk by blowing it out ; finally, let the pipette drain a minute, and then blow the last drop that remains in the point into the flask. After a little practice all this can be done in a shorter time than it takes to describe the operation.

If the pipette is now to be used to take a sample of another milk, it should be filled and emptied two or three times with this milk, just as it was with the first milk sampled. Measure out now, before beginning the analysis of any one of them, all the samples to be taken from milk in hand.

The Analysis :—

Fill the boiling vessel with water up to about half an inch above the perforated false bottom, and bring the water to boiling. Fill the little measuring tube with sulphuric acid up to the mark, and

add this to the milk in the boiling flask; do the same with acetic acid, and mix the whole well together by shaking. Place the flask in the water bath, in which the water must be boiling quietly during the whole operation. While this sample is being heated another may be made ready by the addition of the acids, and then set in the bath. The heating of each flask should be limited to five or six minutes, and during this time the contents of the flask should be shaken once or twice; it is quite important to keep the acids and the milk all the time well mixed together. When the boiling is finished, set the flask in cold water; it will be well to complete the heating of all the samples in hand before proceeding to the next step, as none of them should be boiled more than the time stated above.

When the flask is cold add 4 c.c. of ether, measured out in the other measuring tube, mix well by shaking, and set the flask again in the boiling water for ten or fifteen minutes, or till no smell of ether is perceived at the mouth; this treatment may be given to as many flasks at once as there are places in the water bath. As the result of this operation a layer of clear fat appears at the surface of the liquid.

Holding the fat-measure by the upper end of the side tube, sink it in boiling water till a little runs in at the mouth of the graduated tube, and hold it there a minute or two; then pour out the water that has run in, and pour at once the contents of one of the boiling flasks, taken *directly* from the water bath, into the side tube, rinse the boiling flask with a little boiling water, and pour this in at the side tube, and repeat this rinsing two or three times, or till all the fat is in the fat measure. Then, with boiling water in a little pitcher, with a very small spout, pour more water in at the side tube, thus raising the fat into the graduated tube, and as the level of the liquid approaches the lower end of the graduated tube, add the water *very* slowly; the last portion of the water should be added very carefully so as to bring the lower levels of the column of fat just a little above the lower limits of the graduation. If the column of fat is not perfectly unbroken, a defect that may arise from the entanglement of water with it, get it together by running a very small wisp from a broom up and down through it.

Then *at once* read off the upper and lower levels of the column of fat, reading from the lowermost point of the curved surface of

each level, down to half divisions ; subtract the smaller number from the larger, and in the following table, against the number corresponding to this remainder, find the per cent. of fat in the milk.

Measures of Fat.	Per Cent. of Fat.	Measures of Fat.	Per Cent. of Fat.	Measures of Fat.	Per Cent. of Fat.
1	.346	13½	4.67	22½	7.78
2	.692	14	4.84	23	7.95
3	1.038	14½	5.01	23½	8.13
4	1.384	15	5.19	24	8.30
5	1.730	15½	5.35	24½	8.47
6	2.076	16	5.53	25	8.65
7	2.422	16½	5.70	25½	8.83
8	2.768	17	5.88	26	9.00
8½	2.931	17½	6.05	26½	9.17
9	3.114	18	6.23	27	9.34
9½	3.29	18½	6.40	27½	9.51
10	3.47	19	6.57	28	9.60
10½	3.63	19½	6.74	28½	9.86
11	3.80	20	6.92	29	10.03
11½	3.97	20½	7.09	29½	10.20
12	4.15	21	7.26	30	10.38
12½	4.32	21½	7.43		
13	4.50	22	7.61		

Mr. Cochran stated in his original article on this subject, that this method of determining fat in milk was then (1889) in use in upwards of fifty creameries, mostly in southeastern Pennsylvania, and that with the largest and most improved form of apparatus for the heating of the samples, and after becoming perfectly familiar with the manipulation, sixty tests can be made in from two to three hours.

If scrupulous attention is paid to every detail of the manipulation, as above described, I think that any one who is not too clumsy-fingered and is accustomed to nice careful work, can get reliable results with the method after some practice, such as any method would require. But in any case a little training under the instruction of someone who is perfectly familiar with it would undoubtedly be profitable.

With any such who can spend a week at Ithaca, arrangements will be made, by special correspondence, for such instruction in the laboratory of the Experiment Station. Only two pupils at the most can be taken at once, and therefore this instruction will necessarily be distributed over a large part of the year, in case many should apply for it. All correspondence in regard to the matter should be addressed to Chemical Department, Cornell University.

G. C. CALDWELL.

SPECIAL NOTICE.

After the chemical work was completed of which this Bulletin gives an account, and the matter was prepared for the press, a circular was received at the office of the Experiment Station from parties selling the fat-measure used in this process, as well as the right to use it, under a patent. On further inquiry it proved that such a patent had been applied for. No mention was made of this in the original article on the method, in the *Journal of Analytical Chemistry*, and this circular gave us the first intimation of any such patent claim.

But even if the method is patented, it was decided, after careful consideration of the matter, that it may be no less useful to dairymen, and the issue of the Bulletin was therefore proceeded with.

The fat-measure and the right to use it can be obtained of A. Marshall & Son, 220 N. Fifth St., Philadelphia, Pa. All the other materials can be obtained there also, and probably at about the price for the whole outfit given on page 22 of the Bulletin,

CORNELL UNIVERSITY,

COLLEGE OF AGRICULTURE.

BULLETIN

OF THE

Agricultural Experiment Station.

HORTICULTURAL DIVISION.

XVIII.

JULY, 1890.

EXPERIENCES IN SPRAYING PLANTS.

I. The Effect of London Purple and Paris Green upon Peach Foliage.

II. Trials of Nozzles.

"That art on which a thousand millions of men are dependent for their sustenance, and two hundred millions of men expend their daily toil, must be the most important of all; the parent and precursor of all other arts. In every country, then, and at every period, the investigation of the principles on which the rational practice of this art is founded, ought to have commanded the principal attention of the greatest minds."—JAMES F. W. JOHNSTON.

PUBLISHED BY THE UNIVERSITY,
ITHACA, N. Y.,
1890.

CORNELL UNIVERSITY.

Agricultural Experiment Station.

BOARD OF CONTROL:

Offices of the Director and Deputy Director, 20 Morrill Hall.

Those desiring this Bulletin sent to friends, will please send us the names of the parties.

I. THE EFFECT OF LONDON PURPLE AND PARIS GREEN UPON PEACH FOLIAGE.

The success which has attended the use of arsenical sprays in combatting the curculio upon the cherry and plum, has led to its trial upon peach trees. London purple appears to have been most generally used in these trials, because this material has been strongly recommended during the last few years as preferable to Paris green. The advantages which London purple possesses over Paris green are its cheapness, and the fineness and lightness of the material, allowing it to remain longer in suspension in water. But the use of London purple upon the peach has often resulted in great injury to the foliage, and sometimes to the young shoots. In fact, so serious were the injuries last year, particularly in the peach region of Michigan, and so fully were they discussed in the press, that there appears to have been very few trials of spraying the peach during the present season.

The injuries in the Michigan peach orchards last year led Professor Cook to experiment upon the influence of the arsenites upon foliage. He found (Bull. 53, Mich. Exp. Station) that "peach foliage is especially susceptible to injury," that London purple is more injurious to foliage than is Paris green, and that "this is doubtless owing to the soluble arsenic which is quite abundant in London purple and almost absent in Paris green." The colored liquid left after the complete settling of the London purple was destructive to peach foliage. It appeared that greater injury occurred when the spraying was performed shortly before a rain, and that "spraying soon after the foliage puts out is less harmful than when it is delayed a few days, or better a few weeks." As a general result of the trials upon the peach, it was concluded that Paris green alone should be used, and that "not stronger than one pound to three hundred gallons of water."

In this condition the matter rests. We still need to know if the above conclusions are applicable to other regions and other years, what are the chemical histories of these arsenites, why and

how it is that the poisons injure the peach, if injury is greater at certain seasons of growth, if the time of day, meteorological conditions, methods of application, and other minor conditions, influence the results. It has been supposed by many that the unusual meteorological conditions of last year were largely responsible for the injuries. We performed experiments looking in these directions last year, but desired the experience of a second season to test the subject more fully. We now find that the experiences of the two seasons coincide, so far as the experiments are comparable.

1. Our first trial this year was made May 21st, upon a block of 48 old peach trees. The first leaves at the time were scarcely half grown. Both Paris green and London purple, ranging in strength from one pound to 256 gallons, to one pound to 496 gallons, were used. The results of this test were obscured by a severe attack of curl-leaf, but injury was certainly very slight, if any.

2. May 31st, fourteen young peach trees of several varieties, in another orchard, were sprayed, and also a number of trees of Russian apricots and *Prunus Simoni*, with one pound of London purple to 256 gallons of water. These trees were much farther advanced than those in the first lot. The peach leaves were much injured, and they began to fall in about sixteen days. It was noticed that the poison did not injure the tip leaves, but all those which were fully grown at the time of spraying were killed, and they fell off. Yet, to a casual observer, no injury was apparent because the rapid new growth obscured it. The apricots and *Prunus Simoni* were not injured.

3. Thirty large peach trees were sprayed June 2d, both London purple and Paris green being used, in the proportion of one pound to 200 gallons, and one pound to 256 gallons. These trees were more backward in size of leaves than those in lot 2. The trees treated with the two London purple mixtures were about equally injured. Most of the leaves which were full grown when the poison was applied fell off. About three weeks afterwards the leaves were still falling, yet the shoots were growing so rapidly that not more than ten per cent. of the total foliage of the tree at this time was injured. None of the shoots were injured. A very trifling and unimportant injury resulted from the stronger Paris green mixture (1 lb. to 200 gals.), but none from the weaker one.

4. June 23d, a part of the trees of lot 3 were again sprayed with one pound of London purple to 200 gallons, and adjacent trees, which had not been treated, were sprayed with one pound to 256 gallons. All the trees were very badly injured, and nearly all the leaves which were full grown when the applications were made had fallen in ten days. Many of the shoots were killed, but they were all such as had nearly completed their growth. Most of them were in the center of the tree, and they had probably caught some of the drip from the upper foliage. Some of the shoots had just begun to die ten days after the application. The trees which had received no previous treatment were injured as much as the others.

FIG. 1—*Tree Sprayed Early in the Season.*

5. A number of young and very vigorous trees in a third orchard were sprayed June 23d, a part of them receiving London purple, one pound to 256 gallons, and the remainder one pound of Paris green to 200 gallons. Several varieties were represented in these trees. In three days the trees receiving London purple began to show signs of serious injury. Crawfords suffered much more than Old Mixons, but this may have been due to some unevenness in spraying, although care was exercised to treat all trees alike. In four and five days the leaves began to fall. In seven days the leaves were falling badly, and at this time some injury began to be apparent on the trees treated with Paris green.

The trees sprayed with London purple suffered much. All the leaves which were full grown at the time of application fell off, and as the young leaves are comparatively few late in June, and the growth slow, the trees presented a sorry appearance. Fig. 2 is a good illustration of one of these trees about three weeks after treatment. The young wood also became spotted, and it assumed a deep red color. Many of the shoots were killed outright, and some of the trees are permanently injured. The trees sprayed with Paris green shed a large part of the full grown leaves, but no twigs were seriously injured. Trials with Paris green were further made in lot 10.

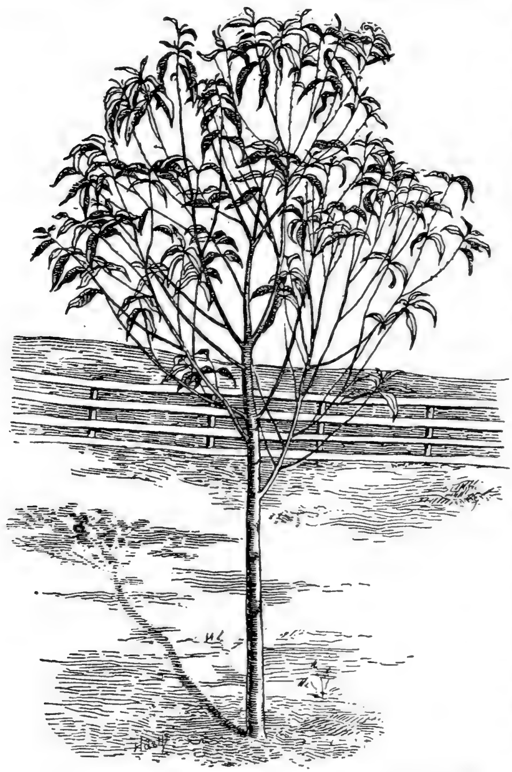

FIG. 2.—*Tree Sprayed Late in the Season.*

6. July 3rd peach trees were treated with 1 lb. of London purple to 400 gals., the material having been mixed immediately before application. An equal number of adjacent trees were sprayed with the colored liquid taken from the top of a similar mixture which had stood fifteen hours. The trees were all equally injured in both lots. A week after the application the full grown leaves were all discolored, but none had fallen. Subsequently they all fell. No twigs were injured. A number of very vigorous young Russian Apricots were sprayed at the same time with the colored liquid. The foliage was considerably injured, perhaps a third of the full grown leaves falling, but the injury was not apparent so quickly as in the peaches. Over three weeks

after the application the leaves were still falling. Plums treated in the same manner were not injured. (See lot 14.)

7. Five days later another application was made upon peach of colored liquid which had stood for fifteen hours above a mixture of 1 lb. of London purple to 400 gals. of water. Again the foliage was killed.

8. July 7th a test was made to determine if the kind of spray influences results. The liquid was applied in three ways, an equal quantity being used in each case: a solid small stream, very coarse spray, and a fine mist-like spray with Nixon No. 3 nozzle. Perhaps the differences in these sprays may be better understood by saying that in applying the solid stream 7 strokes of the pump were required to throw a pint, in the coarse spray 6 strokes, and in the fine spray 12 strokes. Both nectarines and peaches were sprayed. 1 lb. of London purple to 400 gals. was used. The injury from the solid stream and the coarse spray was great and about equal. Upon the peach foliage the fine spray did almost no damage. Upon the nectarine it caused the foliage to drop, but no further injury resulted; while the coarse spray upon the nectarine not only caused the leaves to drop, but seriously injured the shoots, causing the young and remaining leaves to turn yellow. These results are the more singular from the fact that more liquid actually remains upon the tree from the fine spray than from the coarse ones, as was shown by the fact that the drip from the application of the fine spray was much less than from the others. But the fine spray distributes the material more widely and probably prevents the accumulation of sufficient poison at any one place to injure the tissues.

9. A tree six or seven years old was sprayed July 7th with 1 lb. London purple to 400 gals., and immediately thereafter the hose was turned upon it and the foliage was given a thorough washing, so that the water dripped freely from the whole tree. In a week the leaves began to show scorched spots, and eventually many of them fell. But the injury was not great.

10. July 10th large trees were sprayed with Paris green for the purpose of studying further the results obtained in lot 5. Part were treated with 1 lb. to 200 gals., and part with 1 lb. to 256 gals., in a fine spray. The trees receiving the stronger mixture sustained a very trifling injury, none of the leaves falling. The others were not injured, although upon very close observation a very small scorched spot could be found now and then.

The above trials show that peach foliage is very susceptible to arsenical poisons, and that London purple is much more injurious than Paris green. The young leaves are much less liable to injury than the full grown leaves. This, we are satisfied, is due entirely to the waxy covering which is so abundant upon recent leaves and shoots. Late in the season, when the young and waxy growth is slight, nearly all the leaves will be killed by a mixture which would have had scarcely any effect when the tree is just pushing into growth in

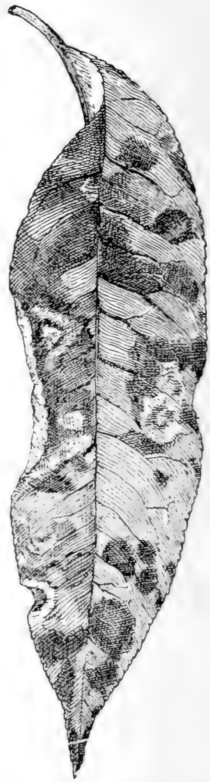

FIG. 3. — *Peach Leaf Injured by London Purple.*

FIG. 4.—*Peach Shoot Injured by London Purple.*

spring. Injury early in the season is less apparent, also, for the reason that growth of new leaves is so rapid that defoliation is obscured. In fact, the casual observer would not have noticed that the trees which shed their leaves in our earlier experiments had sustained the slightest injury ; new leaves formed faster than injured leaves fell. This is admirably shown in figures 1 and 2. Fig. 1

shows a tree in lot 2, three weeks after treatment. All the leaves which were mature at the time of application had fallen, yet the tree appears to be in a perfectly normal condition. Fig. 2 shows a tree in lot 5, three weeks after treatment. At this date the growth had nearly ceased and the injury is glaring.

Injury upon the leaf is first apparent in small and definite reddish-brown spots, which are visible upon both surfaces. The centre of the spot soon assumes a lighter color, and the tissue becomes dead and translucent. The edges of the leaf become discolored in like manner and show a tendency to curl. A close observation discloses the fact that the discolorations take just the shape of the drops or streaks of liquid which lay upon the leaf. Fig. 3 shows a scorched leaf. These leaves are at once distinguished from any which may suffer from fungous troubles by the absence of raised, puffed, or ragged borders about the spots, and by the presence of the scorched margins. Shoots are injured in the same manner as the leaves. Small bright red spots appear, and blotches mark the course of the liquid as it collected and ran down the stems. The whole shoot soon becomes abnormally red, as if its growth were arrested. Sometimes these shoots die outright, but they oftener survive. When the spraying is very copious, so that the liquid washes the foliage, half or more of the leaf may die outright without becoming much spotted. In such cases the injury is quickly apparent. The liquid runs down the stems freely, and they may suffer sooner than the leaves. In some of our trials, the death of the shoots caused the wilting of the foliage, and the leaves hung loosely for some days. Fig. 4 shows this sort of injury. Here it is worth noting that the uppermost inch or two of the twig was not injured, owing to the waxy covering. The tips bend over, at the highest point of injury, giving the tree a wretched appearance.

Microscopic examination shows that the cell walls in the dead spots retain their shape, but the protoplasm is dry and shrivelled. The peach leaf has a very delicate structure, the epidermis being remarkably narrow, with thin-walled cells. This delicacy of structure appears to account for the peculiar susceptibility of the peach leaf to injury: the poison quickly permeates the tissue.

An appeal was now made to the chemist. Leaves injured by London purple in lot 5 were found, after thorough washing, to contain arsenic *in the texture* of the leaf (.0023 grams of arsenic

in 58 grams of leaves). Two analyses of leaves injured by Paris green in the same lot showed no arsenic in the texture of the leaf. The poison in the latter case had acted from the surface of the leaf. It is apparent that London purple is the more injurious because of its soluble arsenic. The arsenic in London purple is in the form of a normal arsenite of calcium, which substance comprises about 72 per cent. of the whole compound, and over *50 per cent. of it, or nearly 40 per cent. of the London purple, is quickly soluble in water.* Paris green contains no soluble arsenic.*

Trials were now made to determine just what portion of the London purple compound is harmful to foliage.

11. Peach foliage was sprayed July 11th with the filtered soluble portion of London purple. The foliage showed marked signs of injury in three days, and a week later the leaves had fallen and the shoots were much damaged. This proves that it is the soluble portion which is hurtful.

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*Those who wish to make a more careful study of the composition of London purple and Paris green are referred to the following determinations by Harry Snyder, Asst. Station Chemist:

London Purple is a refuse from a dye manufactory, and contains, in addition to the dye that is present, arsenic in both the soluble and insoluble forms; and the reactions all indicate that it is in the form of an arsenious compound, and none present in the form of an arsenic. Other substances found to be present are iron, aluminum, and sulphuric anhydride; these, however, were found only in small quantities, which leaves the calcium and arsenic to combine as a calcium arsenite.

There are three arsenites of calcium, corresponding to the formulæ:

1. $Ca_3\ (AsO_3)_2$;	which contains	30.50 per ct. Ca	40.98 per ct. As.
2. $Ca\ (AsO_2)_2$	" "	15.75 " "	59.04 " "
3. $Ca_2\ (As_2O_5)$	" "	25.80 " "	48.39 " "

The first ($Ca_3(AsO_3)_2$) is the normal calcium arsenite.

The London purple yielded on analysis, (average of duplicate results) calcium and arsenic in the proportion of 11.19 per cent. calcium and 14.88 per cent. arsenic; this corresponds to the amount of calcium and arsenic in the normal calcium arsenite, for

$$\begin{array}{cccc} Ca & As & Ca & As \\ 30.50 : & 40.98 :: & x : & 14.88, \end{array}$$

which gives 11.08 per cent. of calcium against 11.19 as found.

Analyses of London purple:

	I.	II.	Average.
$Ca_3(AsO_3)_2$	72.62 per ct.	72.46 per ct.	72.54 per ct.
Fe_2O_3 and Al_2O_3	1.01	1.05	1.03 "
SO_3	.44	.40	.42 "
Moisture,	3.03	2.91	2.97
Dye (by difference)			23.04

The water solution, after being filtered, yielded on analysis an amount of arsenic and calcium in proportion of 9.80 per ct. arsenic and 6.56 per ct. of calcium; these amounts also satisfy the formula, $Ca_3(AsO_3)_2$, showing that

12. A filtered solution from which the arsenic had been removed was sprayed upon peach July 11th. No injury resulted, showing that it is the arsenic and not the dye which is injurious.†

Our trials were made at nearly all times of day, and under various meteorological conditions. Full records were made of all these conditions, but as they appear to have exercised no influence whatever, they need not be discussed here. The notion that foliage may be scorched by spraying with pure water on a bright and hot day has no foundation, else our trees would have been scorched by the Paris green water, which was sometimes applied in very hot and bright weather.

Plums. Serious injury is said to have followed London purple spray upon plum trees in this State, last year. One grower is said to have permanently injured his orchard by the use of one pound of purple to 300 gallons of water, particularly the Bavay (*Reine Claude*). Two tests were made upon vigorous young plum trees :

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the arsenic in solution is in the same condition as that in the original substance. To determine the amount of dye that was soluble, the total nitrogen in the London purple was determined and found to be 1.56 per ct. The nitrogen in the solution was then determined and found to be .30 per ct.; now, since the nitrogen comes from no other source except the London purple, .30 : 1.56 : x : 100 represents the per centage of dye (on the basis of the total dye) soluble in water, and this was determined by difference to be 23.04.

The solubility of London purple is as follows :

Calcium arsenite,	38.08 per ct.
Dye,	4.61 "

This represents 52.38 per ct. of the total calcium arsenite as being soluble in water.

The above samples of London purple were purchased in the open market, and are the same as that used in the orchard tests. A sample direct from the Hemingway Company was found to be equally soluble, containing 39.11 per ct. of soluble calcium arsenite.

Paris green is a compound containing copper, arsenious and acetic acids. It is an aceto-arsenite of copper, having the formula, $Cu(As_2O_4)_3$, $Cu(C_2H_3O_2)_2$. This formula would require copper, 23.92 per ct.; arsenic, 44.47 per ct.; oxygen, .53 per ct.; acetic acid, 11.08 per ct. The sample under examination yielded 23.18 per ct. copper, and 44.16 per ct. arsenic. Some insoluble matter was present, but it was not determined. This represents 97 per ct. of aceto-arsenite of copper, all of which is insoluble in water.

† In order to precipitate the arsenic, the solution was made acid with hydrochloric acid, and this was neutralized with ammonium hydrate, forming ammonium chloride. This substance scorched the foliage, but the whole injury was entirely different from that caused by London purple, and could not be confounded with it for a moment. Moreover, a tree was sprayed at the same time with ammonium chloride as a check, and the same injury resulted. This explanation may be useful to those who desire to repeat the experiment.

13. June 2d, an orchard of many varieties, including Bavay, was sprayed with one pound London purple to 200 gallons. No harm resulted.

14. July 3d, a lot of plum trees, comprising Coe's Golden Drop, German Prune, and Bavay, were treated with the colored liquid which stood above a London purple mixture of one pound to 400 gallons for 15 hours. (Lot 6 was treated with this material). No injury was done.

A careless observer would have said that the plums were injured, as many of the leaves were spotted and often perforated. But these injuries were entirely fungous (in this case, apparently due to *Phyllosticta pyrina*), and were easily distinguished from

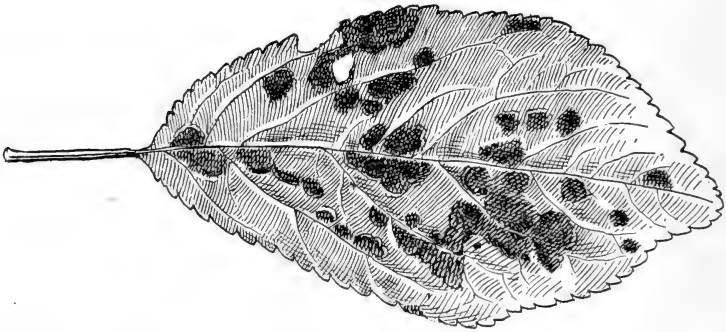

FIG. 5.—*Plum Leaf Injured by Fungus.*

poison injuries. Fig. 5 shows one of these leaves; it should be compared with Fig. 3, and the entire absence of the scalded, blotched and curled appearances noted.

We do not discourage the general use of London purple, as we use it freely upon other plants than the peach.

SUMMARY.

1. Peach trees are very susceptible to injury from arsenical sprays.

2. London purple is much more harmful to peach trees than Paris green, and it should never be used upon them in any manner.

3. Injury is more liable to occur upon full grown foliage and hardened shoots than upon young foliage and soft shoots.

4. The immunity of the young growth is due to its waxy covering.

5. Injury late in the season is more apparent than early in the season, because of the cessation of growth.

6. Injury from the use of London purple may be permanent and irreparable.

7. The length of time which the poison has been mixed appears to exercise no influence.

8. London purple contains much soluble arsenic (in our samples nearly 40 per cent.), and this arsenic is the cause of the injury to peach foliage.

9. A coarse spray appears to be more injurious than a fine one.

10. A rain following the application does not appear to augment the injury (Cf. trial 9. See also trial 6, which shows that the arsenic passes at once into solution without the aid of rain).

11. Meteorological conditions do not appear to influence results.

12. Spraying the peach with water in a bright and hot day does not scorch the foliage.

13. Paris green, in a *fine spray*, at the rate of one pound to 300 gallons of water, did not injure the trees. Probably one pound to 350 gallons is always safe.

II. TRIALS OF NOZZLES.

It is, of course, impossible to say which nozzle is best for applying poisons. Nearly every one possesses some merit which others do not. The cultivator who grows a variety of fruits should possess four or five of the best nozzles. The leading requisites of a good nozzle are ability to throw a copious, forcible and fine spray and some handy means of graduating or varying the same.

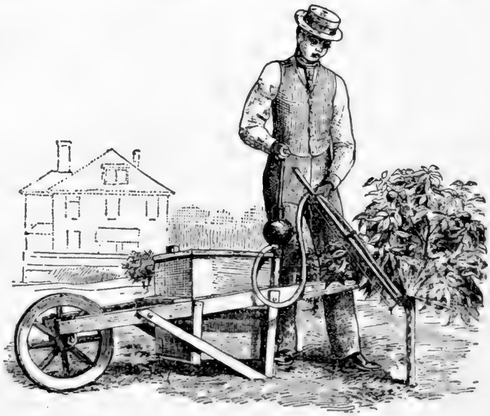

FIG. 6.—*Method of Spraying Bushes.*

For spraying currants and gooseberries, and other low plants where the insects feed largely upon the under surface of the

leaves, we have heretofore used the Cyclone,—or sometimes the Vermorel, which is not so good for this purpose. The nozzle is attached to the end of a strong rubber tubing some five or six feet long. The nozzle and tubing are secured to a light stick, by means of which the nozzle can be held under the bush. The method of application, together with a good home-made wheelbarrow tank, is shown in Fig. 6. The Cyclone nozzle discharges the spray through a very small hole in a brass disc. This hole frequently becomes plugged by sediment, and the pump has to be stopped, the disc unscrewed, and the sediment removed. This occurs so often as to occasion a serious loss of time, to say nothing of the annoyance and the loss of poison. The smallest Cyclones do not allow all the undissolved poison to pass through the aperture. Our currant and gooseberry patches were sprayed many times last year with great thoroughness, and yet the worms constantly kept ahead of us, and the bushes were defoliated.

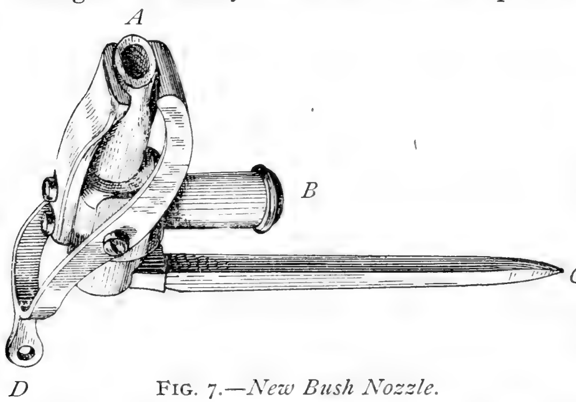

FIG. 7.—*New Bush Nozzle.*

We have devised a bush nozzle upon a new principle (Fig. 7). Its essential feature is the compressing of the end of a rubber tube. At A is a bit of rubber tube, about an inch long, which is slipped over a thin brass collar or cylinder. The tube leading from the pump is attached at B. C is a shank for attachment to a stick. A string is secured in the lever at D, and this passes to the hand of the operator, who, by tightening or releasing the cord, varies the spray instantly. A ring can be secured in the end of the cord and this can be held in place by allowing it to drop into notches on the stick. When the rubber tip becomes worn, another can be slipped on. This is far the most satisfactory bush nozzle which we have ever tried. A single spraying early in the season with this nozzle and Paris green,

kept our bushes clean nearly the whole season, although the young worms were very numerous.

Among nozzles suitable for spraying trees, we have used an ordinary hose-pipe and rose, the Gem Graduating Spray, Boss, Crown, Lowell, Magic, Mistic, and Nixon's Nos. 3, 4, and 5. We have also made a test of these under 20 lbs. pressure, having the following points in mind: fineness and evenness of spray, breadth of spray, force, and convenience of manipulation. It seemed to us that for large trees, the Gem, Mistic, and Boss answered the requirements best. For small trees, the Nixon's are best.

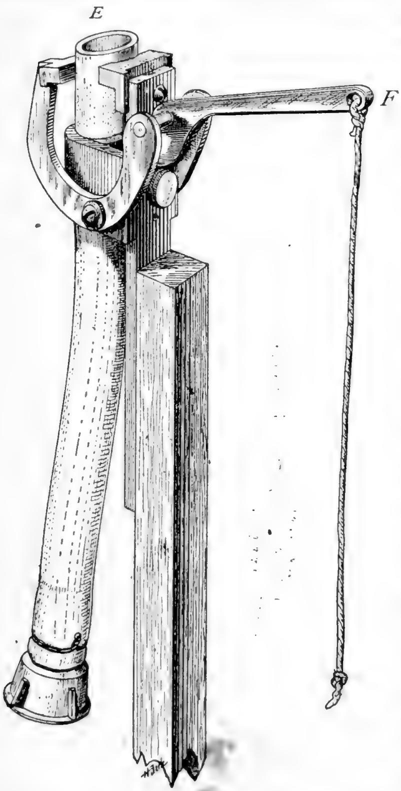

Fig. 8.—*New Tree Nozzle.*

We still need a nozzle for large trees which can be graduated without stopping the pump or lowering the nozzle, and which will not clog. Fig. 8 represents a nozzle which we have made to meet these requirements. Like our bush nozzle, the essential feature of this is the compressing of the end of a hose. In ordinary hose the webbing soon becomes loose at the end and causes the spray to split, so that we were obliged to substitute a strong pure rubber tube, to the end of which the hose is attached. This tube, E, is shoved through and cut off a trifle as soon as the end becomes worn. The nozzle is secured to a stick of the required length, by which the operator elevates it toward the tree, and the spray is regulated at will by means of the cord attached to the lever, F. A set-screw in front of the lever adjusts a clamp which holds the tube in place. All things considered, this is the best nozzle for spraying large trees which we have tried. The adjustment of the rubber tube is somewhat perplexing, however, but this can no doubt soon be remedied by the substitution of a rubber thimble made for the purpose.

L. H. BAILEY.

CORNELL UNIVERSITY,

COLLEGE OF AGRICULTURE.

BULLETIN

OF THE

Agricultural Experiment Station.

HORTICULTURAL DIVISION.

XIX.

AUGUST, 1890.

REPORT UPON THE CONDITION OF FRUIT-GROWING IN WESTERN NEW YORK.

"That art on which a thousand millions of men are dependent for their sustenance, and two hundred millions of men expend their daily toil, must be the most important of all; the parent and precursor of all other arts. In every country, then, and at every period, the investigation of the principles on which the rational practice of this art is founded, ought to have commanded the principal attention of the greatest minds."—JAMES F. W. JOHNSTON.

PUBLISHED BY THE UNIVERSITY,
ITHACA, N. Y.,
1890.

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Agricultural Experiment Station.

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REPORT UPON THE CONDITION OF FRUIT-GROWING IN WESTERN NEW YORK.

The promise of fruit was never better in Western New York than last spring. All orchard fruits, particularly, gave a wonderful profusion of bloom. The apple crop had been light last year, and everyone naturally expected a great harvest this season. Yet the apple crop is almost a total failure, peaches and plums are few, pears are probably less than a half crop, and quinces range from small to fair crops in various sections. Raspberries and blackberries have yielded indifferently. Only the strawberry and grape crops are satisfactory. This general failure is a serious loss to Western New York, which is one of the most extensive fruit-growing districts of the country, and which, all things considered, is undoubtedly the most important apple-growing region in the United States.

The reasons for this wholesale failure should be determined. So far as I am aware, there have been no general investigations to show why blossoms fail to set fruit, although the subject is eminently worthy the attention of investigators. It was so late in the season when we learned of the condition of the orchards that definite study of the causes of the falling of the bloom could not be undertaken; yet something has been learned, and the subject has been opened for research. Regarding the present condition of the trees themselves, which is far from satisfactory, more definite information can be presented.

The spring was exceedingly wet, and mostly cool. When the orchards were in bloom unusually heavy rains fell. Shortly afterwards the blossoms withered and fell, and the leaves of apples, pears and quinces began to blight. The rains were succeeded by drouth, which, in some sections, became severe. During the early part of the season the blight of the foliage increased, until, in July, when I inspected the orchards in Niagara, Orleans, Monroe, Ontario and Cayuga counties, there were thousands of acres of apple orchards which appeared to be dying. In many places the quince orchards appeared to be scorched, and the foliage of

the pears was speckled. Peaches dropped their leaves and fruits early in the season. The blackberries and later raspberries, in some sections, dried up and the bushes looked unhealthy. It is probable that similar injuries extend, in a greater or less degree, to all parts of the State.

I. APPLES, PEARS, QUINCES.

It is an almost universal opinion among growers that the weather is responsible for the general failure, particularly in the case of apples, where failure is the most complete and disastrous, and which were just passing out of bloom when a prolonged storm, of unusual severity and accompanied by lightning, passed over the country. It has long been supposed that cold and heavy rain at blooming time will prevent fertilization of the flowers, and the idea appears to be universally accepted. Yet I know of no reason for thinking it generally true, or at least of sufficient moment to account for the failure of a crop. There are not only strong general reasons for doubting the notion, but several minor observations are also against it. For instance, two Seckel pear trees, equally exposed and of the same age, both of which bore a heavy crop last year, stand but a rod apart, and were in bloom at the same time: one has no fruit and the other is loaded. We have all observed good crops of fruit in years when heavy rains fell at blooming time.

In undertaking to determine why blossoms fail to set, it should be borne in mind that fully four-fifths of the flowers of apples and pears fall naturally. The flowers are borne in clusters, yet the fruits are usually borne singly. The redundancy of flowers appears to be nature's method of insuring fertilization, by increasing the amount of pollen and multiplying the chances of success. The blossom which is strongest, or which gets the best start, wholly aside from its position in the cluster, appropriates energy to itself, while its neighbors fail.*

In most cases the apples had set and were about the size of small peas when they began to die. They withered, turned brown and fell. The date of attack varied somewhat in varieties which bloom at different times. The Greenings died before the the late flowering sorts, but all were probably attacked at about

*See Bailey, Bull. 31, Mich. Exp. Sta. 92.

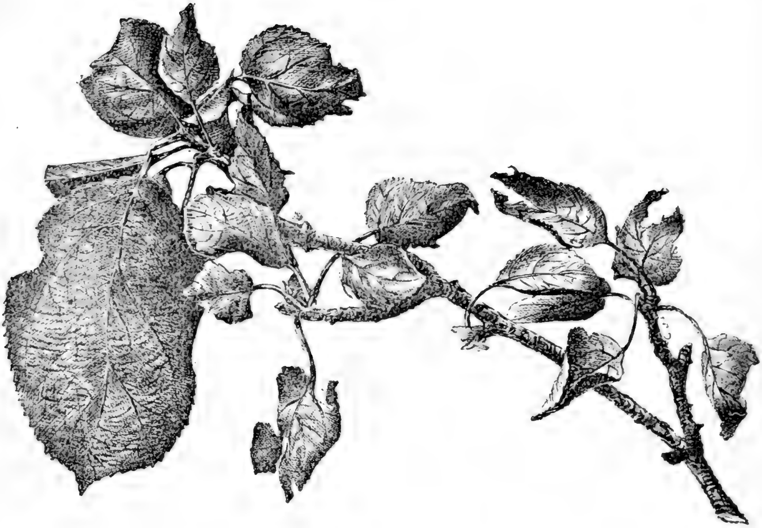

FIG. 1.—*Typical Blighted Foliage.*

the same period of growth. At the same time, the young leaves began to look unhealthy, and they rapidly assumed a blighted appearance. Most growers assert that those trees which bloomed most profusely were most attacked by the leaf blight. Three or four years ago a similar falling of flowers and blighting of foliage occurred, at least in some parts of Orleans county. In that case, however, the attack is reported to have been a little earlier, and the flower clusters often fell off entire. The meteorological conditions were similar in both years.

All these facts show that there is an intimate connection between the death of the flowers or young fruit and the blighting of the leaves. The blight is caused by the apple-scab fungus. Whether the flowers or young fruits were actually attacked by the fungus in this case, or whether they fell because of the impaired vitality of the injured trees, I am unable to say, but it is probable that their death is due in large part, directly or indirectly, to the fungus. Late in the season dead blossoms which still clung to the trees, or which were picked up under them, were studied by Professor Dudley, but they were so overgrown with a common and harmless rust or mold (*Cladosporium*), that he could not determine if the scab fungus had attacked them. The scab

fungus is found upon the bracts or small leaves attending the flower cluster, and it is frequent upon very small fruits. These fruits, sometimes scarcely larger than peas, often hang upon the tree until August, or even later. B. T. Galloway, mycologist of the Department of Agriculture, writes me that he is "convinced that infection usually takes place before the fruit has attained the size of peas," but there is "no evidence that the fungus of apple scab ever attacks the flowers of the apple." A. B. Seymour, of Harvard University, writes that he has never seen the fungus upon flowers, but he has information that it attacks very young pears, causing them to fall. F. S. Earle, of Cobden, Ill., who is both a mycologist and a fruit-grower, informs me that he has "repeatedly found the scab attacking the very young fruits of pears, causing them to shrivel and fall instead of setting."

But one who has visited orchards in many parts of Western New York this season, can readily understand that the diseased foliage itself might be sufficient reason for failure of fruit. Upon trees which were most severely attacked, the growth of the leaves was checked and in August they are still half or quarter size, and dry and stiff. They are often broken and torn by the winds. Upon many trees the late leaves are nearly clean and have grown full size. Fig. 1 is a good illustration of blighted apple foliage. It shows the retarded leaves and a full-grown leaf of late July growth. As a rule, the leaf is nearly covered with a brownish mildew-like growth upon both surfaces. In the early stages of attack the fungus is confined to more or less definite spots, which may be suggested by Fig. 3. The leaf becomes brownish throughout and often curls as if scorched. The sere and scorched appearance of orchards is often visible a half mile away. Fig. 2 shows a branch attacked later in the season, when the leaves are nearly full grown and when the growth of the wood has separated them. This sort of injury is not characteristic of the attacks in Western New York this year, however; and it may also be said that some of this later injury is probably due to other fungi than the apple scab.

This apple scab fungus (*Fusicladium dendriticum*), which is so destructive to foliage, is the one which causes the scab upon the fruit itself. It is nearly always present to a greater or less extent upon both leaves and fruit, but it is rarely so destructive to foliage as this year. It has increased rapidly in New York of

FIG. 2.—*Blighted Foliage.*

late years, and last year the apples were unusually scabby. The wet spring afforded it just the conditions for rapid growth. It appears to be somewhat worse upon low and undrained lands than upon high and warm elevations, although the latter are never by any means exempt in the infected regions. Some growers think that the scant foliaged varieties, like Spitzenburg, are most seriously injured. The growth of the wood is very scant because of the unhealthy foliage.

A closely related species (*Fusicladium pyrinum*, by some regarded as identical with the other) attacks the pear, both fruit and foliage, and it has probably caused much of the failure in the pear crop this year. Upon the pear leaf the fungus has a tendency to remain in more or less definite spots, probably be-

cause of the dense nature of the epidermis of the leaf—so that pear foliage rarely looks so brown as apple foliage. A gall mite sometimes accompanies it, causing the spots to be raised somewhat above the surface. This appearance is more pronounced upon the under surface of the leaf. It is shown in Fig. 4.*

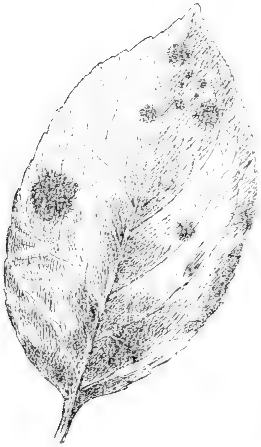

FIG. 3.—*Apple Scab Spots on a Leaf.*

The leaf blight upon the quince, which is very serious in many parts of the country, is caused by an entirely different fungus (*Entomosporium maculatum*; known also as *Morthiera Mespili*). A characteristic injured leaf is shown in Fig. 5. It also attacks the fruit of both quince and pear, causing it to crack. This is the same fungus which attacks stocks of pear and quince and renders the growing of them precarious. I have heard complaints from the large quince growers in the western part of the state that the fruit often blasts shortly after setting and there is reason to believe that this fungus is the cause of much of the mischief. This trouble is so serious in some places that one of our most intelligent quince growers in-

* All the material collected in the Western New York orchards has been examined by Professor Dudley, who contributes the following notes upon it, together with observations upon specimens from other places:

At various times since June 20th, specimens of diseased apple fruits and leaves have been placed in my hands for examination, from the counties of Oswego, Wayne, Ontario, Orleans, Tompkins, and Steuben, the object being to ascertain the cause of the wholesale destruction of the young fruit.

The immature fruits themselves have been found to be attacked by two enemies, first by the apple worm (and this pest has been sufficiently abundant to apparently cause wide-spread injury), second by the apple scab, caused by a parasitic fungus (*Fusicladium dendriticum*). Reports on the latter, with remedy, were published in the Bulletin of the Weather Bureau for July, issued from this University. In many instances this parasite had attacked the fruits when they were no larger than small peas, and it may appear on them at any subsequent stage of their growth until late autumn. The very young fruits usually stop growing, and after a long time gradually wither and fall away. If the apple is as large as a hickory nut before it is attacked, it may develop and ripen; any part not attacked grows out fair and plump, the parts showing the olive-green or blackish, finally scabby spots, usually remaining knotty, indented, and undeveloped.

The apple leaves were also attacked by the *Fusicladium* to an unusually destructive extent, and the blackish-olive, mildewed blotches on the upper surface have been wholly due to this fungus. Often also this appearance was succeeded by the total browning or scorching of the margins or ends,

formed me that he is thinking of cutting down his orchards. This leaf-blight must not be confounded with the pear-blight which attacks the quince as well as the pear. The pear-blight is characterized by the uniform death and browning or blackening of the whole leaf or branch and the entire absence of spots. It has been much less prevalent this year than last, although I have seen serious damage resulting from it in quince plantations. The only remedy for pear-blight is to remove and burn the diseased portions, taking care to cut off the branches several inches below the lowest visible point of attack.

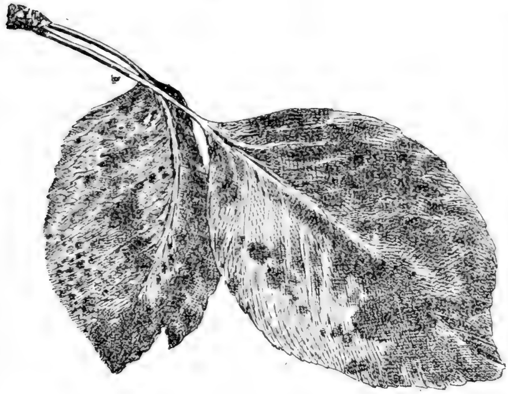

FIG. 4.—*Diseased Pear Leaves.*

Treatments.—The injury to apples, pears and quinces by the

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or by the yellowing and falling of the leaves, some trees becoming largely defoliated.

Two other parasitic fungi have caused browning of apple leaves, in this vicinity this season, but probably the injury caused by either would be insignificant as compared with that by the *Fusicladium.*

Besides the above injuries during the present year, apparently large numbers of the young fruits just at or after the fall of the blossoms, died by whole clusters or corymbs and fell away. Many of these dead clusters were examined some time after they had withered, and a few within two weeks. Unfortunately my attention was not called to them earlier. The cause of this wholesale destruction is not clear at present. At this late date of examination no *Fusicladium* could certainly be detected on the stalk, calyx, etc., of the blossoms thus blighted. The common olive-green mold (*Cladosporium*), found everywhere on dead or dying vegetation, was abundant on them, and it may have overrun and obliterated all traces of the real cause of this blossom-blight. The few specimens examined in June chanced to show none of the *Fusicladium* on the surrounding leaves, as well as none on the dead flower-clusters, an indication, though not a proof, of some other cause. If the young flower-stalks were attacked and destroyed by an early crop of the apple scab parasite, there remained no sure evidence of it, and the settlement of this point must be left until another spring. The mycelium of this fungus does not penetrate the substance of the leaf or fruit to any extent. Its short root-like processes merely spread underneath the outer layer or cuticle of the apple leaf and fruit, and the fruiting branches, bearing the spores, break through the surface, giving the characteristic dark olive or brown color of the "scab." Though not entering deeply, the action of this mycelium is evidently very exhausting, ab-

scab fungus is not a vital one. In the worst cases the vitality of the trees may be checked for a year or two. As a rule, the effect of the leaf-blight, in Western New York this year, will probably be to develop a large crop of fruit-buds. This often follows a checking of growth. A heavy crop followed the failure and blight of three or four years ago. But if next spring should be wet and cool, the fungus would in all probability spread again, as it has this year. At all events, it is to be expected that apples will be scabby, as they have been in other years, and unless the weather is unusually favorable the fruit will be likely to suffer seriously.

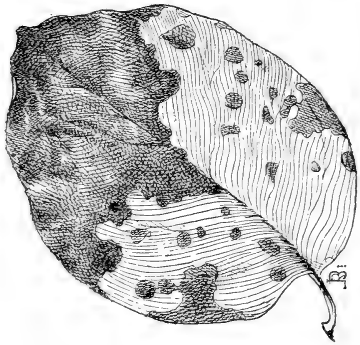

FIG. 5.—*Quince Leaf-Blight.*

The last two seasons have demonstrated that carbonate of copper is a sure remedy for the apple scab fungus. It is not yet fully demonstrated just what are the best times to make the application, but it is necessary to begin before the flowers open, and to make from four to six applications between that time and the first of August. Three applications at any rate should be made,—one before the blossoms open, one just after they fall, and another three or four weeks later. It is probable that some of the fungus

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sorbing the juices and dwarfing the fruits, and often occasioning the death of the leaf wholly or in part, or causing it to become yellow and fall off.

In all the specimens examined from New York the spores,—the reproductive bodies,—have ranged from .015 to .020 millimeters in length, the usual size in American specimens.

In conclusion, it is clear that the failure of the apple crop in New York is due to a far greater extent than usual (but probably not wholly) to the attack of *Fusicladium*, the growth of which was greatly promoted at a critical period of the apple's growth, by the wet, cool weather in which it flourishes best. Whether the early falling of the flowers and young fruit was due to this parasite or not, the flower-buds, before they burst in the spring, should no doubt be sprayed with a strong fungicide, and followed by a weaker solution when the fruit sets, and by successive applications once in two or three weeks if wet weather makes it necessary.

This fungus (or one considered by some as nearly related, but not identical,) attacks young, growing pears, making them one-sided and knotty, and it is abundant this season on the fruits. Most of the black, corky spots on pear leaves abundant last season and this, seem to be due primarily to some other cause—a small gall-mite it is asserted. There are only occasional bunches of the *Fusicladium* found in connection with them.

can be destroyed by spraying even in August and September, but it is doubtful if a fall application would pay its cost. We are now testing this point. These applications, even when a half dozen, need not cost more than 15 to 25 cents for a large tree for the whole season, counting both materials and labor. The following are good formulas:

1. Dissolve 1 oz. carbonate of copper in 1 qt. of aqua-ammonia; dilute with 100 qts. of water when ready to apply.

2. Place 2 lbs. of copper sulphate in sufficient hot water to dissolve it, and in another vessel dissolve 2½ lbs. carbonate of soda. Mix, and before using add 1½ pints of ammonia, and then dilute with water to about 30 gallons. This is the modified *eau celeste* mixture.

The former is probably the better.

The quince leaf-blight (*Entomosporium*) is readily destroyed upon quince and pear stocks by four or five applications of Bordeaux mixture. There is every reason to believe that the remedy is practicable upon full grown quince trees as well. The only experiments yet reported upon orchard trees, so far as I know, were made by Professor Weed, in Ohio, (Bull. 14, Ohio Exp. Sta.), who found that the treatment was effective. The following is a good formula for Bordeaux mixture:

Dissolve 6 lbs. sulphate of copper in 16 gals. water. In another vessel slake 4 lbs. fresh lime in 6 gals. of water. When the latter cools, pour it slowly into the copper solution, mixing the two thoroughly. It is best to prepare the mixture a day or two before using.

II. PEACHES.*

Peaches have suffered from three enemies. The chief cause of the loss of fruit this year in Western New York is undoubtedly the curl-leaf, a fungous disease (*Taphrina deformans*: also written *Exoascus deformans* and *Ascomyces deformans*). Fig. 6 shows a diseased leaf. The leaves become curled, crumpled and distorted early in the season and they soon fall. Nearly all the leaves fell from peach trees last spring over a large extent of country. This loss of foliage caused the death of the young fruits. The dis-

*We have not had opportunity to study the causes of the failure of the plum and cherry crops. Up to the date of writing, the foliage in plum orchards, so far as we know, is healthy.

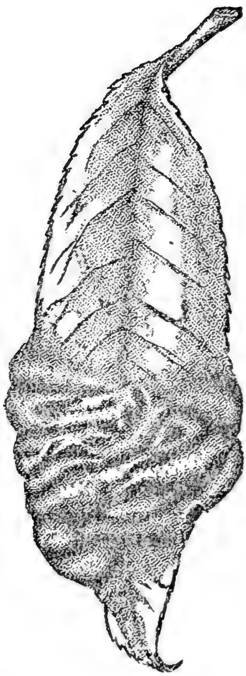

FIG. 6.—*Curl-Leaf of the Peach.*

ease soon runs its course and new leaves appear. In vigorous orchards it seldom injures the trees to any extent. Its most serious feature is its indirect effect upon the young fruit in cases of bad attacks. No remedy is yet known, and even if we knew one it would probably not be generally used as the disease is uncertain in its attacks. Burning the diseased leaves may be practiced in small plantations. Professor Scribner suggests, as an experiment, a spray of sulphate of iron in spring before the buds swell.

Whatever fruits ran the guantlet of the curl-leaf were attacked by curculio, the insect which produces the worm in the fruit. This pest is becoming very abundant and growers must persistently fight it or give up the growing of peaches. It is readily held in check by the familiar process of jarring onto sheets. Paris green at the rate of 1 lb. to 350 gals., applied several times, beginning just after the blossoms fall, will undoubtedly be found useful.*

The third enemy to peach growing in New York, and by far the worst one, is the yellows. The cause of this disease is not definitely known, but it attacks trees of all varieties and ages and under all conditions, and it spreads from orchard to orchard. The only remedy is to cut out every affected tree. This must be done systematically and thoroughly, or peach culture is doomed. I find that the law is not being enforced as vigorously as it ought; it can afford protection to peach growers, and no effort should be spared to apply it.

Yellows may be termed a constitutional disease. It progresses somewhat slowly in the infected tree, and for that reason it is usually neglected. It does not, of course, cause the falling or the blasting of the flowers or fruit, but as it is becoming a serious

*London purple should not be used on peach trees. See our Bulletin XVIII, just issued, concerning the spraying of the peach, and the values of various nozzles.

menace to peach culture in Western New York, it may be considered here. A complete diagnosis is not necessary. The disease is readily distinguished by premature fruit, which bears definite reddish spots which extend into the flesh and usually reach the pit. If the tree is not in bearing, the first symptom will be the appearing of thin, yellowish and small-leaved short shoots on the body and larger branches. At first these shoots may appear singly; one is shown natural size in Fig. 7. Soon, however, these "willow shoots," as they are called in Western New York, appear in bunches, and each one has a tendency to branch the first year. Fig. 8 shows one of these clumps which pushed out on a limb an inch in diameter. Upon trees in regular bearing, these shoots are the second symptom of yellows. A yellows tree soon becomes weak and yellowish throughout, the leaves are small, and in about three years it dies. Yellows must not be confounded with yellowness. The former is a specific disease; the latter is caused by anything which lowers the vitality of the tree.

FIG. 7.—*Yellows Shoot.*

III. SMALL FRUITS.

The most serious trouble among small fruits which has come under our observation this year is the anthracnose or cane-rust of raspberries (known as *Glœosporium venetum* or *G. necator*). It also attacks the blackberry. This attacks the growing canes,

causing them to appear scabby and pitted. (Fig. 9.) The blotches are brownish-black, and at picking time they are usually conspicuous. The disease weakens the canes and the berries dry up as if suffering from drouth. It also attacks the leaves. It appears to be widely distributed in New York. Our own plantations, particularly the Shaffer, are becoming badly diseased. In one of the large raspberry plantations in Orleans Co., run in connection with an evaporating establishment, the disease occasioned a serious loss.

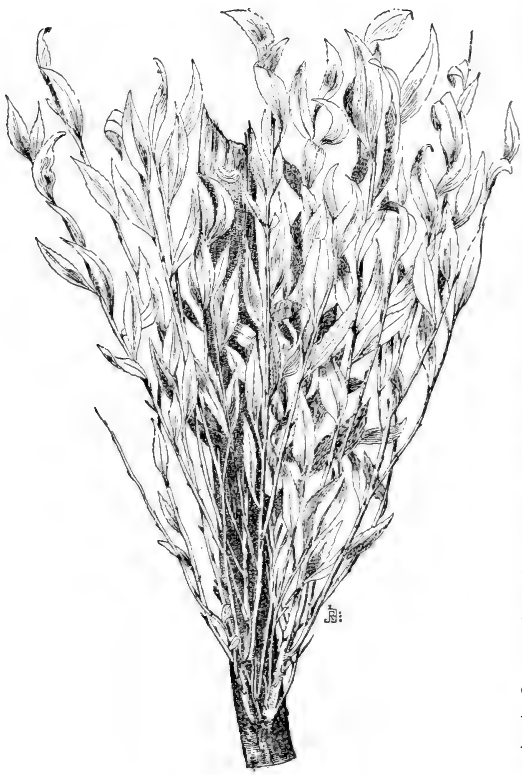

FIG. 8.—*Yellows Tuft.*

In the treatment of this disease it is very important that the plants be kept in a thrifty condition. Our bushes have suffered less than others we have seen in market patches which were less severely attacked, simply for the reason that they are robust. It is not necessary to practice laborious culture. We treat our plantations cheaply by cultivating them lightly once or twice a week until the berries begin to ripen, and again after the berries are off until well into August. Light and frequent cultivations in loose and well-tilled soil are much less expensive than half the amount of tillage upon neglected or poorly treated soil, and their effect upon the plants is greater.

There have been no systematic experiments published, so far as I am aware, upon the treatment of raspberry anthracnose with

fungicides. We have already cleaned out and burned the old canes and the trimmings in our diseased plantations, and early in spring we shall begin the use of fungicides. We shall spray before growth begins with sulphate of iron (about 1 lb. to the gallon), and shall follow with Bordeaux mixture or carbonate of copper, or both, after the leaves appear. We have

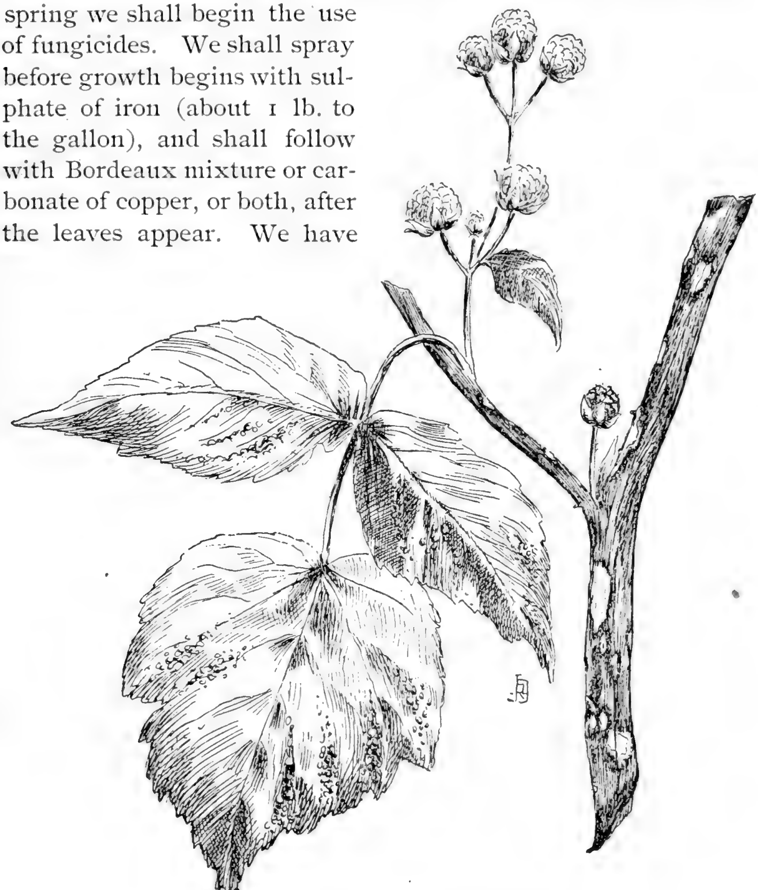

FIG. 9.—*Anthracnose of Raspberry.*

already (early in August) sprayed part of our bushes with Bordeaux mixture, but this is simply an experiment, and we do not look for very profitable results, as the spores have mostly disappeared at this season. But there is every reason to expect that the disease can be held in check by timely treatment. The value of any treatment will be greatly enhanced if the diseased canes are cut and burned as soon as done fruiting.

The strawberry blight (*Sphærella fragariæ;* known also as

Ramularia Tulasnei) has been bad in some sections and upon some varieties. This disease is fully discussed by Professor Dudley in BULLETIN XIV of this Station. The most approved remedy is potassium sulphide or sulphuret ("liver of sulphur") sprayed upon the vines about once in a week or ten days, from the beginning of the growing season until the fruit begins to ripen, at the rate of about 1 oz. to 8 gallons. After the crop is gathered the plants may be mown and burned off, or destroyed by spraying with 1 pint of sulphuric acid to 6 gallons of water. New leaves soon start up, and the plants are not injured.

IV. GRAPES.

The grape crop is fair to good, but rot and mildew are appearing in many places. It has often been said that the climatic conditions are such in the famous grape regions about the central New York lakes that the grape diseases can not thrive, but this notion is clearly erroneous. We also warn our readers not to put faith in statements that certain varieties are exempt. Some of the most serious cases of disease which we have seen this year were noticed upon a variety which has been said to be free from attack.

The advent of the rots and mildews in the New York vineyards is not a cause for alarm. They are to be expected, and they will undoubtedly spread. But the means are at hand to keep them in check easily and economically. Some of the vineyardists are now using fungicides with good success. The anthracnose appears to be particularly injurious in attacking the wood, especially of nursery stock. This is the fungus which causes the scab of the berry. Upon the wood it causes black, shallow pits.

The mildews and rots can be kept in check by the timely and persistent use of Bordeaux mixture. Begin before the flowers open and spray every week or ten days until well into August.

For anthracnose, sulphate of iron applied before the leaves appear, is probably the best remedy. After treatment should be made with Bordeaux mixture.

In conclusion, we urge upon fruit growers the importance of considering the advisability of endeavoring to secure a state law looking towards the control of contagious plant diseases. New Jersey has lately made such a law. Some officer should be empowered to look after these interests when occasion requires.

L. H. BAILEY.

CORNELL UNIVERSITY,

COLLEGE OF AGRICULTURE.

BULLETIN

OF THE

Agricultural Experiment Station.

AGRICULTURAL DIVISION.

XX.

SEPTEMBER, 1890.

I. Cream Raising by Dilution.

II. Variations in Fat of Milk Served to Customers in Dipping from Cans.

"That art on which a thousand millions of men are dependent for their sustenance, and two hundred millions of men expend their daily toil, must be the most important of all; the parent and precursor of all other arts. In every country, then, and at every period, the investigation of the principles on which the rational practice of this art is founded, ought to have commanded the principal attention of the greatest minds."—JAMES F. W. JOHNSTON.

PUBLISHED BY THE UNIVERSITY,
ITHACA, N. Y.,
1890.

CORNELL UNIVERSITY.

Agricultural Experiment Station.

Offices of the Director and Deputy Director, 20 Morrill Hall.

Those desiring this Bulletin sent to friends, will please send us the names of the parties.

CREAM RAISING BY DILUTION.

It has been recommended that in the absence of ice the addition of an equal quantity of water either hot or cold to fresh milk in deep cans would secure rapid and complete creaming. To compare this method with the ordinary one of setting the milk in deep cans in ice-water, and further to test the efficiency of creaming by diluting the milk with water in various amounts and at different temperatures, experiments have been undertaken.

The milk was in all cases the mixed milk of the University herd, the cows of which are about two thirds high grade Holstein and one-third high grade Jersey. About one-third of the cows were fresh and the rest had been in milk from five to eight months. The analyses were made by Mr. Harry Snyder, Assistant Chemist.*

A large number of trials were made in which portions of milk diluted with an equal weight of cold water were compared with portions from the same milkings set in ice water in the Cooley creamer. The milk in some instances was brought directly to the dairy house after milking, thoroughly mixed and one portion set at once in ice water in the Cooley creamer, the remainder was diluted with an equal weight of cold water and set in a Cooley can in the open room. In other cases milk was taken for the settings that had been carried on the milk route for about an hour and a half. All such cases are marked in the tables with an asterisk (*).

Skimming from deep cans was in all cases done by drawing the skim milk from the bottom of the can, care being taken not to draw the skim milk off so closely as to disturb the cream.

Trials were also made in which a smaller amount of both warm and cold water was added to the milk, and a few trials were made with deep setting in the open air without the addition of water,

*Mr. Snyder has furnished the following notes in regard to methods of analysis: "In all of the analyses the fat was determined by Dr. Babcock's Asbestos Gravimetric Method. Instead of test tubes, fodder tubes as described by Professor Caldwell in Bulletin XII of this Station, were used. The asbestos was prepared in the following way: Ignited, washed with distilled water and extracted with ether. Along with each set of twelve, a blank determination was made. Duplicates were made of all analyses, and, in case a parallel was lost, that sample was not included in the average of all the results."

of setting in shallow pans, and of setting in the creamer with the water of the University water-works at a temperature of something over 60 running through it.

In the following table the results of the comparisons between setting in ice water and diluting with an equal bulk of cold water are shown, those on the same horizontal line being in all cases from the same sample of milk. The percentage of fat in the skim milk has been corrected for the amount of water added.

TABLE I.

			Set in ice water in Cooley Creamer, Temp. 44°.			Set in Cooley Can in Air and Diluted with Equal Weight of Cold Water.					
Date and Time of Setting.	Temp. of Milk . . .	Per ct. of Fat in Milk.	No. of hours set. . .	Weight of Milk, lbs.	Per cent. of Fat in Skim Milk.	Weight of Milk, lbs.	Per cent. of Fat in Skim Milk.	Temp. of water added.	Temp. after Setting.	Temp. of Room. . .	No. of hours set. . .
Sept. 10, 7.00 A.M.	90	3.62	22	18.	**.32**	18.50	**1.58**	47	68	60	22
" 10, 8.30 A.M.	*78	3.62	21	9.	**.20**	9.50	**1.08**	50	64	60	21
" 10, 5.30 P.M.	*84	4.31	23	32.	**.29**	19.	**1.22**	48	67	62	23
" 11, 5.45 P.M.	*84	4.39	23	16.	**.36**	18.75	**1.50**	58	70	62	23
" 11, 5.45 P.M.	*84	4.39	12	15.	**.17**	18.75		58	70	62	12
" 12, 7.00 A.M.	87	4.09	23	18.	**.21**	16.50	**1.24**	60	74	63	23
" 15, 8.00 A.M.	†101					36.	**1.26**	48	73	60	23
" 15, 6.00 P.M.	†100		12	37.75	**.21**	20.	**1.28**	56	76	66	23
" 16, 5.30 A.M.	91		11	18.50	**.18**	8.50	**1.04**	47	66	62	24
" 16, 8.00 A.M.	*83		22	13.25	**.29**	10.25	**1.04**	47	65	62	22
" 16, 6.00 P.M.	*86		12	17.25	**.21**	16.75	**1.34**	48	66	65	12
" 17, 5.30 A.M.	91		12	16.50	**.23**	15.	**1.46**	48	70	60	12
Average, 11 trials, ...					**.23**		**1.28**				

* Carried on route. † The milk in these two cases had been carried on the route, but was heated up to 100 degrees before setting.

Armsby found‡ in between two and three hundred settings of the milk of single cows, Jerseys and Jersey grades, an average of .35 per cent of fat in the skim milk. We may therefore use our results with the Cooley creamer as a standard of comparison. It will be seen that when the milk was diluted with water there was contained in the skim milk nearly six times as much fat as when the milk was set in the Cooley creamer with ice water, or in other

‡Bulletin No. 7 Wisconsin Agricultural Experiment Station.

words, while 95.18 per cent. of the fat in the whole milk was recovered in the cream under the cold deep setting process, but 69.19 per cent. of the fat in the whole milk was recovered in the cream when set in the diluted process. That is, in 100 lbs. of milk containing 4.12 lbs. of butter fat, under the Cooley process, there would be a loss of but .20 lbs. of butter fat, and under the diluting process a loss of 1.27 lbs. It will be noticed also that the per cent. of fat in the skim milk is no higher in those cases where the milk had been carried about on the route before setting, than it is when the milk was set directly from the cow.

Below is given in detail the results of ten settings where the milk was diluted with hot water. In the first three and last cases the milk was set in Cooley cans in the air, in the other six, the cans were put in the creamer and the water allowed to flow through constantly. In all cases skimming was done in twenty-four hours.

TABLE II.

SET IN COOLEY CANS IN AIR AND IN RUNNING WATER, AND DILUTED WITH HOT WATER.

Date.	Temp. of Milk . . .	Per ct. of Fat in Milk.	Weight of Milk, lbs.	Per cent. of Water added.	Temp. of Water added.	Temp. of Milk after Setting.	Temp. of air or running water in tank.	Per cent. of Fat in Skimmed Milk.	
Aug. 20 . .	90	4.30	15	20	134	96	67	**1.78**	Set in air.
" 21 . .	92	4.15	15	20	132	98.5	72	**1.16**	
" 22 . .	92	4.06	15	20	132	100	62	**1.04**	
" 24 . .	91	4.65	15	20	136	98	63	**1.22**	Set in running water.
" 29 . .	90	5.05	12	50	130	104	64	**.84**	
" 31 . .	90	4.81	35	10	120	94	61	**1.10**	
" 31 . .	90	4.81	28	25	120	97	61	**1.10**	
Sept. 1 . .	*80	3.88	35	10	120	84	60	**1.03**	
" 1 . .	*80	3.88	14	25	120	90	60	**.79**	
" 11 . .	83		16	100	130	108	59	**1.04**	Set in air.
Average, ten trials, ...								**1.11**	

* Had been carried on milk route before setting.

It will be seen that so far as the fat in the skim milk is concerned, diluting the milk with various percentages of hot water gave but very little better results than diluting with an equal

amount of cold water. Moreover, in all the cases in which hot water was added, the milk was sour, or very nearly so, at the end of twenty-four hours, and in some cases souring had gone so far that the cream was much injured for butter-making. It will be noted that the surrounding temperature in these trials ranged from 59° to 72°.

Mr. J. L. Hills, Chemist of the Vermont Agricultural Experiment Station, seems to have obtained results* by diluting milk with hot water quite at variance with ours. He found in the skim milk .37 per cent. of fat when the milk was set at 45°, .84 per cent. when the milk was set at 58° and not diluted, and .35 per cent. when the milk was set at 58° and diluted with one-third its bulk of water at 135°. Skimming was done at the end of twenty-four hours, and, as with us, the cream was usually almost or quite ready for the churn when skimmed.

Beside the tests made with cold water, as given in Table I, several other trials, with the addition of various smaller per centages of cold water, were made. The results are given in detail in Table III. In the first four trials the cans were set in the air; in the last two they were set in the tank with water at 64° running through. In all cases skimming was done at the end of twenty-four hours.

TABLE III.

SET IN COOLEY CANS IN AIR AND RUNNING WATER, AND DILUTED WITH COLD WATER.

DATE.	Temp. of Milk	Per ct. of Fat in Milk.	Weight of Milk, lbs.	Per cent. of Water added.	Temp. of Water added.	Temp. of Milk after Setting.	Temp. of Room or water in tank.	Per cent. of Fat in Skim Milk.
Aug. 20	90	4.30	8.5	20	54	83	67	**1.09**
" 21	92	4.15	15	20	54	87.5	72	**1.76**
" 22	92	4.06	15	20	54	86	62	**1 51**
" 24	91	4.65	30	20	54	84	60	**1.18**
" 24	91	4.65	15	20	54	84	63	**1.12**
" 29	90	5.05	12	50	52	76	64	**.78**
Average, six trials								**1.24**

* Vermont Agricultural Experiment Station, Newspaper Bulletin No. 3.

It will be noticed in Table III that the addition of twenty to fifty per cent. of cold water gave almost exactly the same results as the addition of 100 per cent. of water, as shown in Table I. Two settings, in which the milk was not diluted at all, were made in Cooley cans, set in running water, and gave rather better results, as follows :

TABLE IV.

Set in Cooley Cans—No Water Added.					
Date.	Temp. of Milk.	Per cent. of Fat in Milk.	Weight of Milk, lbs.	Temp. of Water in Tank.	Per cent. of Fat in Skim Milk.
Aug. 24	91	4.65	35.5	63	**.90**
" 31	90	4.81	28	60	**.87**
Average, ...					**.89**

Three different trials of setting in shallow pans were made. The first one was only allowed to stand twenty-four hours ; the second was allowed to stand forty-eight hours ; the third stood twenty-four hours, but had added to it at the time of setting one-third its weight of water, at a temperature of 120°. The results are in the table below :

TABLE V.

Set in Shallow Pans.						
Date.	Temp. of Milk.	Per cent. of Fat in Milk.	Weight of Milk, lbs.	Temp. of Air.	Temp. after Setting.	Per cent. of Fat in Skim Milk.
Aug. 31 .	90	4.81	12	64	90	.49
Sept. 14 .	92	4.31	106	62	92	.46
Aug. 31 .	90	4.81	12	64	94	.75

Setting in shallow pans without the addition of water gave much better results than any other system, except deep setting in ice water.

Churn Tests.

Five churn tests were made, two of cream from milk set in Cooley creamer, in ice water, two of cream from milk, to which an equal weight of cold water had been added, and set in air, and one of cream from milk set in shallow pans. The results are given in the table below :

TABLE VI.

DATE.	TREATMENT.	Weight of Milk. Lbs.	Weight of Cream. Lbs.	Weight of Butter. Lbs.	Pounds of Milk required for one of butter
Sept. 13	Milk set in ice water	114	23.25	5.35	21.31
Sept. 13	Milk diluted with cold water.	100.50	15.50	2.75	36.54
Sept. 18	Milk set in ice water	86.75	18.	4.42	19.63
Sept. 18	Milk diluted with cold water.	91.50	16.25	2.69	34.01
Sept. 16	Milk set in shallow pans. . .	106	13.75	4.41	24.03

The two churnings of Sept. 13 include the settings of Sept. 10 and 11, as given in Table I, and are comparable with each other, having been taken from milk that was thoroughly mixed and divided before setting. In the same way the two churnings of Sept. 18 are comparable. The cream was obtained from the settings of Sept. 15 and 16, of Table I. The churning of Sept. 16 was the cream of the setting of Sept. 14, in Table V. In all of these cases the cream was churned when just ripe. The first two were churned at a temperature of 65, the second two at a temperature of 62, and the last at a temperature of 66. The buttermilk was drawn off when the butter granules were of the size of kernels of wheat, and the butter thoroughly washed in the churn, taken up, salted one ounce to the pound, and allowed to stand for twenty-four hours. It was then reworked and weighed. This is the weight given in the table.

It is worthy of note that the results of the churn tests corroborate with emphatic significance the work of the chemist. While from 114 pounds of milk set in ice water 5.35 pounds of butter were obtained, or one pound of butter from 21.31 pounds of milk; from the corresponding 100.5 pounds of the same milk diluted with water under the conditions mentioned, only 2.75 pounds of butter were obtained, or 36.54 pounds of milk were required to produce a pound of butter, showing an actual loss in butter by the use of the dilution process of 1.94 pounds per hundred pounds of milk as compared with deep setting in ice water.

In looking up the literature of the subject while these experiments were in progress, we find that the whole idea of adding water to milk to hasten and perfect the creaming is not new. Kirchner in his "Milchwirthschaft," p. 179, quotes with approval the experiments of Martiny and Peters.* In these experiments

*Martiny, Die Milch, Vol. II, page 32, Dantzic, 1871.

one hundred per cent. of water was added to milk set comparatively shallow in open air at a temperature of 68 to 74, with results as follows, in two different trials with milk of different quality.

a. 100 grams milk without water gave 6.05 grams cream, 1.69 grams fat.

a. 100 grams milk with 100 per cent water gave 10.41 grams cream, 1.00 grams fat.

b. 100 grams milk without water gave 7.3 grams cream, 2.94 grams fat.

b. 100 grams milk with 100 per cent. of water gave 9.13 grams cream, 2.88 grams fat.

These figures in general coincide with our own except that in the second of the two trials closer results as between the two methods were obtained than in any of ours.

Finally we have grouped together the average percentage of fat in the skim milk under the several different methods of setting. In each instance correction has been made for the water added.

In eleven trials where the milk was set in the Cooley creamer with ice water, at a temperature of 44°, the average per cent. of fat in the skim milk was	**.23**
In eleven trials where milk was diluted with an equal weight of cold water and set in the open air, the average per cent. of fat in the skim milk was	**1.28**
In six trials where milk was diluted with 20 and 50 per cent. of cold water, the average per cent. of fat in the skim milk was .	**1.24**
In ten trials where milk was diluted with 10 to 100 per cent. of its weight of hot water, the average per cent. of fat in the skim milk was	**1.11**
In two trials where milk was set in deep cans without dilution, in running water at 60°–63°, the average per cent. of fat in the skim milk was	**.89**
In two trials where milk was set in shallow pans, at 60°–64°, the average per cent. of fat in the skim milk was	**.48**
In one trial where milk was set in shallow pans and one third of its weight of water at 120° added, the per cent. of fat in the skim milk was	**.75**

VARIATIONS IN FAT OF MILK SERVED TO CUSTOMERS IN DIPPING FROM CANS.

The following extract recently appeared editorially in a leading dairy paper:

"It is our opinion—decided—that peddling milk in a city, either by dipping the amount for each customer, from the top of the carrying can, or drawing it from the bottom through a faucet, should both be prohibited by law—with pains and penalties just as stringent as those that now legally apply to a deliverer of milk to a factory that has in it less than three per cent. fat. Why? Because cream mounts to the surface of a body of milk with far more alacrity than many suppose, and is dipped off to the first few customers served; they get more than their share of cream and the last served get skimmed milk, no matter how godly may be the intentions, or how vigorous the efforts of the distributor. . . . . When we were in the milk testing business, we tried it for one milk deliverer, and found there was just about half as much fat in the last drawn quart as in the first dipped off."

To determine just how much variation there is in the fat of milk served to the different patrons of a route by dipping, a member of the station staff accompanied a milkman as he went upon his route, and as the milk was about to be served to various patrons took samples for analysis. The milk was the mixed milk of a herd of native and grade cows. The dipper, such as is ordinarily used by milkmen, was provided with a long handle so that it rested on the bottom of the can when not in use. The milk was not stirred except by the motion of the wagon and the raising of the dipper.

The following twelve samples were taken, and yielded to analysis the following percentages of fat, the figures representing the average of parallel determinations:

No.	1, . . .	4.52	Taken from Can A.
"	2, . . .	4.43	
"	3, . . .	4.41	
"	4, . . .	4.32	Taken from Can B.
"	5, . . .	3.85	
"	6, . . .	5.05	
"	7, . . .	4.15	Taken from Can C.
"	8, . . .	4.02	
"	9, . . .	4.05	
"	10, . . .	4.94	Taken from Can D.
"	11, . . .	4.78	
"	12, . . .	4.85	

The milk was contained in four thirty-quart cans. The night's milk of the evening previous was in the cans marked A and C, and stood at a temperature of 64. The morning's milk was in cans B and D, and stood at a temperature of 72. The following notes were taken in regard to the samples :

Sample 1—Taken from A at 5.50 a. m., within a few rods of starting.

Sample 2—Taken when the milk in A was half gone, at 6.10. Seventeen dips had been made since No. 1 was taken, and three-fourths of a mile traveled.

Sample 3—Taken from the bottom of A at 6.20. Twelve dips had been made since No. 2 was taken, and three-fourths of a mile traveled.

Sample 4—Taken from the top of B at 6.10, three-fourths of a mile from starting.

Sample 5—Taken from the middle of B at 7.20. Six quarts had been added to B at 6.35, and two and one-fourth miles traveled between taking samples 4 and 5. Temp. of milk 72.

Sample 6—Taken from the bottom of B at 7.55. One and three-quarter miles traveled since taking sample 5.

Sample 7—Taken from the top of C at 6.20, one and one-half miles from the start.

Sample 8—Taken from the middle of C at 6.50. One mile had been traveled since taking No. 7. Temp. 64. At 6.35 six quarts remaining in the bottom of A and about an equal quantity bought of another dealer, had been added to C.

Sample 9—Taken from the bottom of C at 7.00. Fifteen dips had been made and a half mile traveled since 8 was taken.

Sample 10—Taken from the top of D at 7.50. Tem. 68.

Sample 11—Taken from the middle of D at a time when the wagon had stood still for four minutes with the dipper resting on the bottom of the can. Time, 8.15, and one mile traveled since 10 was taken.

Sample 12—Taken from the bottom of D.

It will be noted that in three of the cans, A, C, and D, that the samples taken are practically identical in quality, and that while there is considerable variation in the samples taken from can B, much the richest one of all was taken from the bottom of the can.

That there might be no question as to the results, two more trials were made. The samples were taken under the same general conditions as in the previous trial, with the extra precaution to take duplicate samples, marked *a*, and *b*, Of these as in the other case, parallel determinations were made, and the figures as before show the averages of the parallels in per cent. of fat :

SECOND TRIAL.

	a.	b.	Average.	
Sample 1, ...	4.86	4.78	4.82	(Before starting.)
Sample 2, ...	4.71		4.71	(Top of can.)
Sample 3, ...	4.82		4.82	(One-third gone.)
Sample 4, ...	4.83	4.74	4.78	(Two-thirds gone.)
Sample 5, ...	4.73	4.82	4.77	(Bottom of can.)

The results of the duplicates in samples 2, and 3, were unfortunately lost during the course of analysis. Sample 1 was taken from the top of the can after the milk had been thoroughly mixed. Sample 5 was taken at the close of the route and the few quarts remaining were thoroughly mixed before the samples were taken. The other samples were taken at about equal intervals. The variations in the results both as to samples and duplicates fall entirely within the limits of error of chemical analysis. Indeed, there was often as much variation in the parallel determinations of *a* and of *b*, as between *a* and *b* themselves, and the table shows that there is in general no more variation between samples, than between *a* and *b*.

In the third trial the samples were taken, and the analyses made exactly as in the second, the results are given below :

	a.	b.	Average.	
Sample 1, ...	4.20	4.16	4.18	(Top of can.)
Sample 2, ...	4.11	4.00	4.05	(One-fourth gone.)
Sample 3, ...	4.13	4.01	4.07	(One-half gone.)
Sample 4, ...	4.15	4.04	4.09	(Three-fourths gone.)
Sample 5, ...	4.01	4.00	4.00	(Bottom of can.)

It will be seen that the variations in this trial are just about the same as in the second, and are entirely within the limits of error of chemical analysis.

The analyses in all cases were made as described by Mr. Snyder in the first article of this Bulletin.

It would seem, therefore, that where milk is peddled by dipping from the can with an ordinary dipper, and where no stirring is done except by the motion of the wagon and raising the dipper, substantial justice is done all the patrons so far as the amount of fat apportioned to each is concerned. This conclusion seems the more justified as each trial was made on a different milk route, and represents the usual custom of three different milk men, since each man was cautioned at the beginning, to in no wise depart from his ordinary practice.

HENRY H. WING,
CLINTON D. SMITH.

CORNELL UNIVERSITY,

COLLEGE OF AGRICULTURE.

BULLETIN

OF THE

Agricultural Experiment Station.

HORTICULTURAL DIVISION.

XXI.

OCTOBER, 1890.

Tomatoes.

"That art on which a thousand millions of men are dependent for their sustenance, and two hundred millions of men expend their daily toil, must be the most important of all; the parent and precursor of all other arts. In every country, then, and at every period, the investigation of the principles on which the rational practice of this art is founded, ought to have commanded the principal attention of the greatest minds."—JAMES F. W. JOHNSTON.

PUBLISHED BY THE UNIVERSITY,
ITHACA, N. Y.,
1890.

CORNELL UNIVERSITY.

Agricultural Experiment Station.

Offices of the Director and Deputy Director, 20 Morrill Hall.

Those desiring this Bulletin sent to friends, will please send us the names of the parties.

NOTES OF TOMATOES.

1. *Effects of breeding.* The most important result obtained from several years of experimentation with the tomato, is an illustration of the value of careful and systematic selection of stock. These results have been marked in other years, but never to such an extent as in the present season. Unusual care was exercised in the selection of stock seed in 1889, and in the case of the Ignotum careful breeding has been practiced for several seasons. Our whole trial ground may be said to have been planted with pedigree seed this year, for the stock was obtained from our own selections of 1889, from special stock contributed by the introducers of standard varieties, and from the originators of the new and untried sorts. As a result, our plantation was the most uniform which we have ever seen, with remarkably regular and handsome fruits. This result alone is ample reward for the endeavors of the five years through which our tomato studies have been running.

In our selections, we have invariably placed greater value upon the character of the stock plant itself than upon individual fruits: we have been impressed with the fact that seeds from a comparatively poor fruit upon a plant which bears many good fruits, give better results than seeds from an unusually good fruit borne upon a plant of indifferent character. This is quite the reverse of common practice, but it appears to be justified in our experience. The following figures illustrate the point: This year we grew two lots of the Volunteer under like conditions. One lot was from commercial seeds, and the crop was in every way typical of the variety. The other lot was grown from seeds obtained from a small and inferior fruit (only ¾ in. in diameter) which was taken from a plant bearing mostly large fruits. The yield from the first lot—commercial seeds—previous to frost, was 6.7 lbs. per plant, with an average weight per fruit of 5.3 oz. The yield from the second lot was 8.8 lbs. per plant, with an average of 7.3 oz. per fruit. Similar results were obtained with

the Mikado. By selecting seeds from plants bearing the greatest number of regular fruits, we have secured plants of this variety more regular in fruit than the commercial stocks.

2. *The effect of heavy fertilizing.* Our experiments last year* showed that the common notion that heavy manuring lessens productiveness of the tomato is open to doubt. Excessively manured soil gave nearly twice heavier yields than unfertilized soil and a third heavier than nitrate of soda treatment. The test was repeated this year upon the same areas, as follows:

I. Originally rich garden soil, 60x30 ft., received 5,460 lbs. of rotted stable manure in 1889 and 1,490 lbs. in 1890. Fifty plants of Ignotum were grown upon this plat this year.

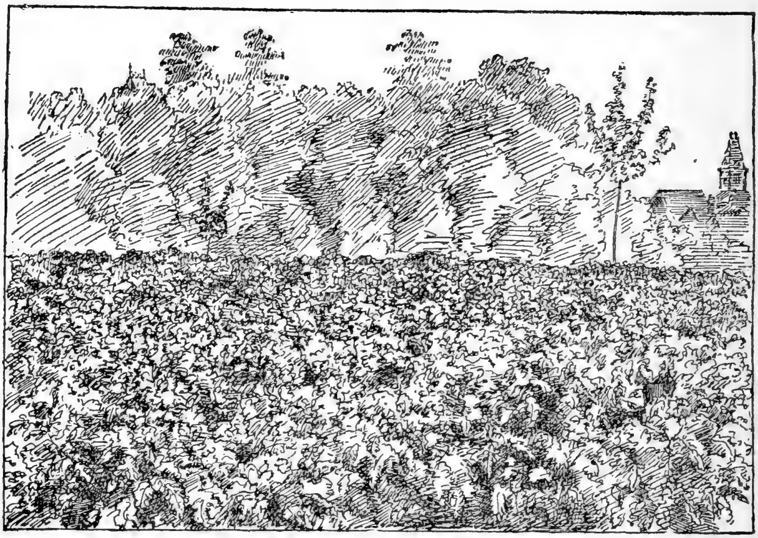

FIG. 1. PLAT I.—HEAVY MANURING.

II. Adjoining plat I, but considerably poorer in quality—some of the surface soil having been removed in 1888—was treated to nitrate of soda in 1889. This year a space 30x36 ft. was selected, set to 24 plants of Ignotum, and treated broadcast with nitrate of soda as follows: 2 lbs., June 24; 2 lbs., July 18; 4 lbs., Aug. 5.

III. An area of the same size as plat II and which bore a crop of tomatoes in 1889, without fertilizer, was this year treated broad-

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* Cf. Bulletin X.

cast with muriate of potash as follows; 2 lbs, June 24; 2 lbs., July 18; 4 lbs., Aug. 5.

IV. A small area of soil similar to plats II and III, unfertilized, for comparison. A part of this unfertilized plat, however, had nitrate of soda treatment last year and a part had no fertilizer last year. There was no apparent difference in the two parts of it, showing that any remaining nitrate had passed out of reach of the plants.

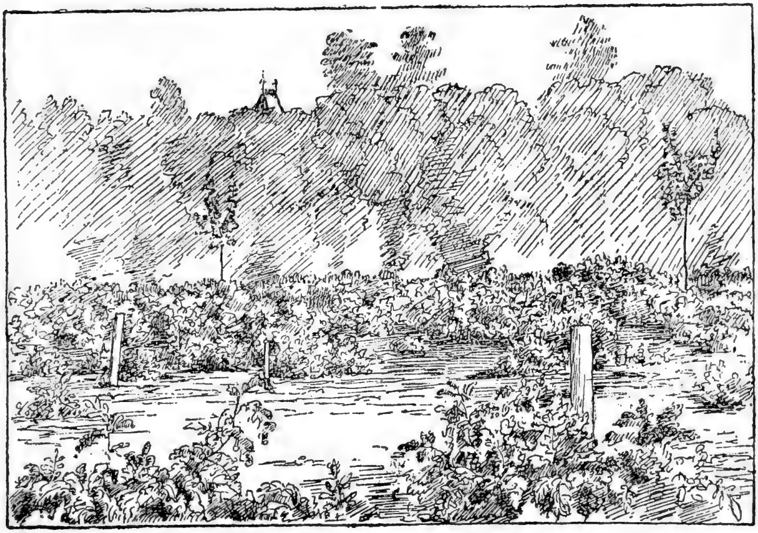

FIG. 2. PLAT II.—NITRATE OF SODA.

V. These plats were compared with the same variety grown upon ordinary garden loam which had received a liberal application of manure, as might be practiced upon commercial plantations.

The results are striking:

Plat.	Average No. fruits per plant.	Average product per plant.	Average wt. of individual fruits.
I.	15	12.9 lbs.	14 oz.
II.	3	1 lb.	5.7 "
III.	3	1 "	5.2 "
IV.	4	1.3 "	5.2 "
V.	11	11.3 lbs.	8.4 "

These figures bear out all the results of last year, and seem clearly to prove that excessive manuring on garden loam does not lessen productiveness. It is extremely doubtful, however, if this very heavy manuring pays its cost, especially in gross productiveness; but it is worth while to observe that the individual fruits on the heavily manured plants averaged more than a half heavier than those on liberally manured garden soil. If tomatoes are profitable in proportion to their size and weight, it would appear that the heavy manuring in this case might be commercially profitable. The results obtained with liberal manuring under commercial conditions (Plat V), as compared with the figures obtained from no fertilizing and from nitrate and potash treatments, certainly show that good stable manure in abundance can be used profitably. Figures 1 and 2 show the external differences between plats I and II. Figure 2 is also a good illustration of the appearance of plats III and IV.

It has been said, in discussions of our tests of last year, that the results would have been reversed if the tests had been made upon clayey soils. We have consequently applied the investigation to very heavy clay this year, as follows:

Plat VI, 50x45 ft., stiff and heavy clay, was given a dressing of 3,640 lbs. of rotted stable manure, and 96 Ignotum plants were set upon it. Previous to frost, the average yield per plant was only 1.5 lbs., as compared with 11.3 lbs. upon the garden plantation (Plat V), and the average weight per fruit was only 5.8 oz., against 8.4 oz. upon the other plat. This shows that the clay plat gave a crop of no commercial value whatever. It is not so clear, however, that this result was due to the manure. In the first place, heavy clay is not fit for tomato growing and there is really no occasion—other than the suggestion of critics—for attempting this experiment. Fully a month elapsed before the plants obtained sufficient hold upon the soil to begin to grow. Heavy rains followed frequently during June and July and packed the soil, and allowed of no adequate cultivation. If the manure had any important influence upon the crop, it was undoubtedly a beneficial one in loosening the soil.

These experiments were not undertaken to determine the relative values of different fertilizers for the tomato, and we hope that no one will draw any such conclusions from them. They show, however, that neither nitrogen nor potash alone, upon rather poor soils, give profitable results.

3. *Early and late setting.* Trials last year showed that early sowing in the North results in increased profitable productiveness. In extension of these facts, some investigations were made this year in reference to the comparative values of early and late setting out of doors. It is commonly taught—or at least it has been by the writers—that tomato plants should not be put out of doors until all chilly weather is over, that any check to the young plants is never outgrown. This appears to be sometimes true, but the following tests indicate that we must not be dogmatic upon this point :

A batch of Ignotum plants was separated into two lots. Half of them were set out of doors May 9th in a rich sandy loam. The plants were very stocky, and were about a foot high. They were set during a very cold rain, and cold and dark weather followed for several days. For about three weeks the plants made no growth. The remaining plants were set alongside the others June 12th. At this time the weather was warm and settled, and it was the season of our general setting. The plants had been shifted in the house and they were in prime condition for the race. The early set plants responded quickly to the first warm days of June ; they were already well established in the soil, while the late set plants had to wait to gain a foothold. The first ripe fruit was picked from each row the same day, August 5th. But the late set plants did not come into full bearing until a month later, while the others bore steadily from the first picking. The numerical results are as follows :

Lot.	No. ripe frts. before Sept. 5.	Total No. of ripe frts. from 12 plts.	Total wt. from 12 plts.	Average wt. of individual fruits.
Early Setting,	**37**	354	**140** lbs.	6.3 oz.
Late Setting,	**8**	66	**30** "	7.3 "

4. *Seeds vs. cuttings.* It is frequently said that plants grown from cuttings are superior in earliness, and sometimes in productiveness, to those grown from seeds, and some growers carry over a few stock plants of tomatoes in a greenhouse or conservatory for the purpose of securing spring cuttings. A house of forced tomatoes gave us a good opportunity to test this point. Ignotum, Lorillard and Sunrise were employed. Cuttings were made

March 29th, and were subsequently handled the same as seedling plants. Seeds of Ignotum and Lorillard were sown April 1st, and seedlings of Sunrise sown January 15th were used in the test. We obtained the following figures from the plants:

Variety.	No. of plants.	No. ripe frts. before Sept. 1.	Average wt. of product per plant.	Average wt. of individual fruits
Ignotum,				
Seedlings,	12	17	6 lbs.	8.4 oz.
Cuttings,	6	4	3 "	7.6 "
Lorillard,				
Seedlings,	12	37	4.9 "	5 "
Cuttings,	4	6	4.2 "	6 "
Sunrise,				
Seedlings,	6	2	2 "	4.7 "
Cuttings,	2	0	1.1 "	4 "

These figures show that the seedlings gave the earliest and largest returns. The numbers of plants in the contrasted lots were not the same, so that the second column of figures does not represent proportionate earliness. Making the proper calculations, however, we find that twice the number of fruits were ripe per plant Sept. 1st upon the seedlings as upon the cuttings. The figures stand as follows, respectively, in favor of seedlings:

17:8. 37:18. 2:0.

The lateness of the planting and certain other causes resulted in a poor yield, but this fact does not invalidate the figures for comparison.

5. *Trimming,* Plants of Potato Leaf, Golden Queen, Volunteer, and Bay State were headed back from three to six inches on all the leading shoots July 28th and August 25th, and all the sprouts from the base of the plants were taken off. In every case there was an important gain in earliness and productiveness in favor of the trimmed plants. The labor of trimming is very slight, and it would appear to be profitable. The following figures show the extent of gain:

Variety.	Average No. frts. per plant Sept 1.	Average No. frts. ripened Sept. 24.	Av. wt. of product per plant.	Av. wt. individual fruits.	Per cent. increase by number.	Per cent. increase by weight.
Potato Leaf,						
Trimmed	6	32	8.7 lbs.	4.4 lbs.		
Not Trimmed	5	27	9.2 "	5.4 "	**18.5**	**−5.7**
Golden Queen,						
Trimmed	4	31	8.7 "	4.5 "		
Not Trimmed	5	21	5.7 "	4.2 "	**47.6**	**52.6**
Volunteer,						
Trimmed	6	31	10.7 "	5.4 "		
Not Trimmed	2	21	6.1 "	4.6 "	**47.6**	**75.4**
Bay State,						
Trimmed	3	19	7.1 "	6.0 "		
Not Trimmed	3	18	6.5 "	5.6 "	**5.5**	**9.2**

6. *Double flowers and irregular fruits.* Double or monstrous tomato flowers produce irregular or rough fruits, and it has been said that if the first flower which appears on any plant is double, all the fruits of that plant will be irregular also,—in other words, that the first flower indicates the character of the plant. Some have even recommended that the plant be discarded if the first flower is double. To determine this point, all the plants on a large plat were watched as they were beginning to bloom. It soon became apparent that this doubling is largely a varietal tendency, some kinds having nearly all the first blossoms double, while on others none could be found. In Mikado, Morning Star, and a canner's variety from Salem County, New Jersey, the habit was most marked. In those varieties in which most of the first blossoms are double, the first fruit of the succeeding cluster was double also ; and those varieties which are most given to the production of such blossoms bear the greatest number of irregular fruits, as a rule. But the first blossom is by no means an index of the character of that plant ; and this is true whether the variety is one in which the habit is marked, or one which simply chances to give an occasional double flower. It would be utterly

impossible to pick out the plants which bore such blossoms by any comparison of fruit later in the season.

7. *Notes of yields.* The season has a profound influence upon tomato yields. If the weather is cool and dark in early September, when the main pickings are coming on, the crop will likely fall below the profitable limit, and if frost should come early, half the crop may be lost in this State. This unpropitious weather of early fall usually brings on the rot, causing additional loss. The chief object of forcing the plants in spring is to escape these calamities to a great extent by inducing the plants to bear early. These calamities overtook our crop this year, so that our yield of marketable fruit is small. The plants set full, and at the first killing frost, Sept. 24th, fully half the crop was immature. Our plants were started late to avoid all labor possible in the handling of a large test plantation, and as our results were to be comparative only, no loss followed. But every year's experience strengthens the conviction that in the North tomato plants should be started early and forced rapidly. The results from early and late settings on a previous page point in the same direction. In our short seasons it is difficult to secure the large yields of the Middle States. The same operations of forcing are probably not equally valuable in Maryland and New York. A trip through Delaware and Maryland this fall brought to mind the differences in yields between the Middle and Northern States in a most forcible manner. The plantation in the Cornell gardens had been killed by frost and half the tomatoes were still immature. The southern plantations were still green and scarcely any fruit remained on them. Frost was unusually late in Delaware and Maryland this year, perhaps, but the observation was inevitable that growers there with little effort harvest a crop which, in ordinary years, we can obtain only under the most forceful culture.

Yet our yields are not so small as they have been represented to be. Even in this very poor year, the average yield per plant of marketable tomatoes, before frost, from our common garden plantation was 11.3 lbs. If plants are set 4x4 ft. apart, this means over 15 tons per acre. The yields in the New Jersey, Delaware and Maryland fields, even with the longer seasons, by which two or three pickings are gained, are from 8 to 16 tons. Last year our common plantation yielded an average of 12.5 lbs. per plant of marketable fruit, before frost. We have never seen

commercial plantations so vigorous and relatively productive as our own common plantations have been. If similar treatment were applied, even in part, to the tomato fields which supply the canneries, greatly increased yields would be sure to follow. The treatment is simply this: careful selection and breeding of stock seed from year to year; early sowing; frequent or occasional transplanting, producing stocky plants; rich soil, well prepared and well tilled. If the grower has facilities for forcing the plants rapidly, the first half or the middle of March is a proper time for seed sowing in this latitude.

8. *Impressions of varieties.* Our list of varieties was greatly reduced this year. We found that we could not profitably carry more than a dozen or fifteen of the old varities, even for experimental purposes. About forty sorts altogether, were grown. Many were local varieties sent in for trial, and all the new kinds offered by the trade were obtained. It is not our purpose to pronounce definitely upon the merits of the new tomatoes which appear from year to year. Our tomato studies have a deeper purpose, which is not yet completed and has not been reported. In the meantime, various comparatively incidental matters of treatment and varieties may, perhaps, be worthy of record.

We are still confirmed in our belief that varieties of tomatoes are unstable and that they soon "run out." The strongest proof of this fact, perhaps, is the difficulty of maintaining any variety true to its type under good culture and careful selection. The variety under this treatment is very apt to "improve," or depart from its original character. An apt illustration of this has come to our experience this year in the Trophy. In our last year's report we observed that this standard variety is running out and that it is difficult to procure typical stock of it. A careful Long Island gardener opposed the statement and cited the fact that he had kept the Trophy (though somewhat *improved*) all these years by careful treatment. He furnished us seeds, but we secured few fruits which could be called the Trophy as that variety was known in its early days. Most of the fruits were smooth and even, medium in size and much flattened, and they were better, in our judgment, than the true Trophy was. It is a common but erroneous notion that "running out" necessarily means deterioration.

Atlantic. (*Atlantic Prize.* Johnson & Stokes).—One of the best early varieties. Ripened earlier, and fruit was more regular than in 1889, though not so large. Fruit large, red, firm. Productive.

Bay State. (Bragg).—Earlier than last year. Of good size; usually smooth, slightly wrinkled at base. Firm and good; cracks but little. A worthy variety.

Beauty. (Livingston).—The best of the pink tomatoes. A desirable sort for either market or home use.

Brandywine. (Johnson & Stokes, 1889).—Medium size, bright red, usually regular. Less inclined to crack than some other varieties. Rather late.

Chemin Market. (Vaughan).—Of medium size, deep red, somewhat elongated. Resembles Hathaway (*Hathaway's Excelsior*). Smooth, prolific, uniform in size and shape. Good.

Dwarf Champion. (Burpee).—Somewhat more satisfactory than in 1889, the fruit being larger and a little earlier. Very handsome, and valuable for amateur culture, both in the field and under glass, but ripens too slowly for market purposes.

Favorite. (Livingston).—This is still superior to the new comers, and is the second best tomato in our plantations this year.

German Raisin. (Childs).—Only the common currant tomato (*Lycopersicum pimpinellifolium*). Seldom used, except for ornament or as a curiosity.

Golden Fig. (Childs).—Small, golden yellow. Plant vigorous and very productive. A short remove from Yellow Plum. Valuable for pickling.

Golden Queen. (Livingston).—Undoubtedly the best yellow sort. Of medium size; usually even and regular in form. Productive and reasonably early.

Ignotum.—This still retains its place at the head of all tomatoes which we have ever grown. It was not quite so early as last year.

Ithaca. Fig. 3.—Medium size, about 3 inches in diameter, nearly spherical, very smooth and remarkably uniform in size; color, light cherry. A new variety, very promising among table tomatoes; apparently valuable for forcing, in which capacity we shall test it during the winter. The history of this promising variety is as follows:

About twenty years ago, L. S. McWhorter, a retail grocer of Ithaca, was attracted by a very fine specimen tomato, shown by an old English gardener, purchased the fruit, and the succeeding year planted the seed in his private garden. The parent was the French *pomme d' amour*, or "Love Apple." Some years after one plant appeared, which was a marked improvement. From this, Fred McWhorter, his son, has made careful selec-

tions for several years until he has secured a superior strain. It is strictly a local variety. We shall not dispose of seeds this season.

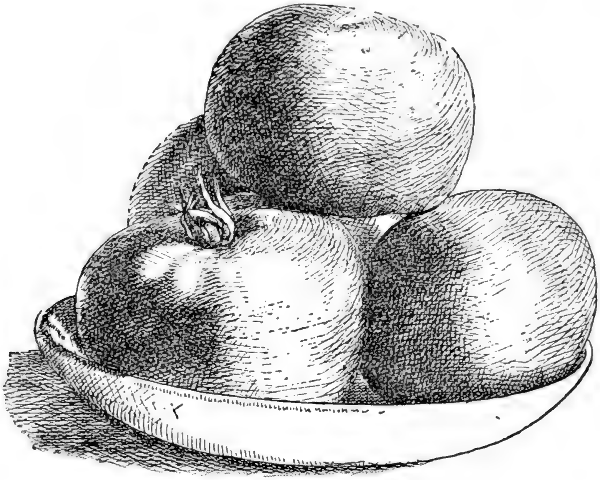

FIG. 3. ITHACA—½ NATURAL SIZE.

La Crosse. (Salzer).—Indistinguishable from Dwarf Champion.

Lorillard.—More satisfactory as a field tomato than in 1889, yet not equal to many other varieties for this purpose. As a forcing tomato it ranks very high, and upon this use of it we shall report in due time.

Mansfield Tree. (Mills).—A rampant grower, bearing large and very irregular fruit. Somewhat like Acme in appearance, but far more irregular. Not productive, and unpromising. The most ridiculous things have been claimed for this variety.

Matchless. (Burpee).—A good late variety. Smooth, even, firm, bright red; not so frequently cracked at base as many.

Morning Star. (Salzer).—Indistinguishable from Mikado.

Prelude.—Very early and very prolific, but small. Average weight of ripe fruit, less than two ounces. An acquisition for the home garden.

Red Cross. (Gregory).—Much like Perfection, but evidently inferior to it.

Ruby. (*Early Ruby.* Henderson).—Medium size, bright red, early, productive. First fruits even in size, smooth, and very handsome. Later in season, more irregular fruits appear. Promising.

Ruby Queen. (Childs).—Evidently the same as Table Queen of Henderson.

Sacramento.—A local variety sent us from California as Sacramento Favorite. A medium sized red variety, similar to Perfection, but evidently in no way superior to it.

Table Queen. (Henderson).—Mikado with ordinary foliage. Fruits average a little larger, and are a little more irregular than Mikado. They ripen at the same time, hence there is no call for both.

Station. (New York Experiment Station, Geneva).—This is evidently a variable variety. Our stock was very like the French Upright in habit, but the fruit is small and regular. Valuable only as an amateur fruit.

Volunteer. (Thorburn).—More satisfactory than last year. Uniformly of medium size, smooth and regular. Similar to Perfection.

A local and unnamed variety raised by the large growers in Salem County, New Jersey, was tested. It is a very large, irregular sort, vigorous and productive, but uneven in size and character; late. Under careful breeding it may become a promising variety.

Of the forty varieties grown this year the following seem to be the best for market purposes:

Red.—Ignotum, Favorite (or Puritan), Bay State, Atlantic, and perhaps Ruby.

Pink.—Beauty, Mikado, and possibly Potato Leaf.

Yellow.—Golden Queen, and, for pickles, Golden Fig.

To these, for amateur culture, may be added Station, Dwarf Champion, and Prelude.

Of the newer introductions, Ruby and Chemin Market are promising. Mansfield Tree is not to be compared with many of the older varieties. There is no room for Ruby Queen, the place being already occupied by Mikado. La Crosse and Morning Star are old friends in disguise.

SUMMARY.

1. The tomato plant is quickly susceptible to careful selection.

2. As elsewhere in the vegetable kingdom, the character of the plant as a whole appears to have more hereditary influence than the character of the individual fruit.

3. Very heavy manuring does not lessen productiveness.

4. Neither nitrate of soda nor muriate of potash alone are profitable tomato manures upon thin soil.

5. Very early setting of stocky plants in the field, even in dark and raw weather, augmented earliness and productiveness this season.

6. Seedlings gave far better results than cuttings.

7. Trimming the plants lightly late in summer gave a greatly increased yield.

8. A double or monstrous flower upon a young plant is no indication that succeeding flowers upon the same plant will be double, and produce irregular fruits. But varieties which habitually bear double flowers are also the ones which habitually bear irregular fruits.

9. Cool and dark weather in early fall, and early fall frosts, are the leading drawbacks to profitable tomato culture in the North. To avoid these dangers as much as possible, plants must be started early and forced rapidly.

10. The essential general points in profitable tomato culture are these: Careful selection and breeding; early sowing; frequent or, at least, occasional transplanting to obtain stocky plants; rich soil, well prepared and well tilled.

11. There is evidence that varieties of tomatoes run out, even under good culture.

12. The best market tomatoes appear from our tests to be Ignotum, Favorite, Bay State, Atlantic, and perhaps Ruby among the red varieties; Beauty, Mikado, and possibly Potato Leaf among the pink or purple varieties; Golden Queen among the yellow sorts.

13. Among the novelties, Ruby and Chemin Market are most promising.

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CORNELL UNIVERSITY,

COLLEGE OF AGRICULTURE.

BULLETIN

OF THE

Agricultural Experiment Station.

AGRICULTURAL DIVISION.

XXII.

NOVEMBER, 1890.

On the Effect of a Grain Ration for Cows at Pasture.

"That art on which a thousand millions of men are dependent for their sustenance, and two hundred millions of men expend their daily toil, must be the most important of all; the parent and precursor of all other arts. In every country, then, and at every period, the investigation of the principles on which the rational practice of this art is founded, ought to have commanded the principal attention of the greatest minds."—JAMES F. W. JOHNSTON.

PUBLISHED BY THE UNIVERSITY,
ITHACA, N. Y.,
1890.

CORNELL UNIVERSITY.

Agricultural Experiment Station.

Offices of the Director and Deputy Director, 20 Morrill Hall.

Those desiring this Bulletin sent to friends, will please send us the names of the parties.

ON THE EFFECT OF A GRAIN RATION FOR COWS AT PASTURE.

This investigation is a continuation of a similar experiment carried on at the station in the summer of 1889 and reported under the above title in Bulletin No. XIII, for December, 1889. With slight variations, that will appear in their proper places in the text, the experiment of the past summer is a duplicate of that conducted in 1889, the details being as follows.

THE COWS.

Six cows were divided into two lots of three each, so that the lots should be as evenly matched as possible in age, milking qualities, condition of flesh, and distance from calving. Four of the cows were from the University herd, the other two were bought for the purpose and were natives, fresh in milk and very thin in flesh.

Lot I.—Fed no grain.

No. 1: Glista, thoroughbred Holstein, three years old, dropped last calf April 22, 1890. Not bred.

No. 2: Cora, high grade Jersey, about six years old, dropped last calf March 26, 1890, bred May 10, 1890.

No. 3: Shadow, native, five years old, dropped last calf about April 1, 1890. Not bred.

Lot II.—Fed grain.

No 1: Jane, high grade Holstein, seven years old, dropped last calf April 9, 1890. Not bred.

No. 2: Gem of Spring Brook, thoroughbred Jersey, six years old, dropped last calf March 4, 1890, bred May 24, 1890.

No. 3: Phantom, native, three years old, dropped last calf about April 1, 1890. Not bred.

The uniformity of the two lots at the beginning of the experiment, is shown by the following table:

TABLE I.

	Average age. Years.	Average weight. Lbs.	Average milk yield per day. Lbs.	Average No. of days since calving.	Average No. of days in calf.
Lot I	4⅔	983	28.8	49	5
Lot II	5⅓	870	28.5	60	0

THE METHOD OF THE EXPERIMENT.

The experiment was commenced on May 25, at which time the cows were turned from winter feed into a rich pasture and the grain feed entirely taken away from lot I. Lot II continued to receive a grain ration the same in amount and character as they had been getting during the winter and spring on dry feed. It was made up of a mixture of 200 pounds of wheat bran, 150 pounds of cotton seed meal, and 15 pounds of malt sprouts. Of this mixture, cows Nos. 1 and 2 ate nine pounds each per day, and cow No. 3 six pounds per day at two equal feeds, morning and night when they were brought into the stable to be milked.

The experiments of 1889 were not commenced until June 8 at which time the cows had been for some weeks on pasture with a light grain ration. This ration was taken away from lot I and was continued with lot II. The difference in feeding in the two years was therefore as follows: In 1890 the grain-fed lot (Lot II) received a grain ration the same in amount and character on dry feed and on pasture continuously, and the pasture-fed lot (Lot I) had their entire grain ration suddenly taken away at the time of going on grass. In 1889 the grain-fed lot (Lot II) received much less per day than had been fed during the winter on dry feed, while lot I had for several weeks received the light summer ration of grain before their grain feed was entirely taken away.

The pasture, the same one as was used in 1889, was almost entirely blue grass on a dry gravelly upland soil. Up to about the 20th of July the pasture was rich and luxuriant; from then till about the 20th of August a very severe drought prevailed and the pasture was supplemented with second growth clover scattered to the whole herd each day. After the 20th of August, frequent rains restored the luxuriance of the pasture.

The cows were milked at about half past four in the morning, and about half past three in the afternoon, and the milk weighed

as it came from the cow. For three days in each week at first, and afterward in each alternate week, the milk was analyzed. As soon as milked and weighed, the milk of the cows in the same lot was mixed and a sample taken. The evening sample was kept on ice until morning and with the morning sample taken to the laboratory where the two were thoroughly mixed and the total solids and fats determined.

The cows were selected and the milk weighed and analyzed for two weeks before the feeding began so that data might be secured, as to the normal amount and quality of the milk from the two sets.

THE RESULTS IN MILK AND BUTTER.

The time of feeding extended from May 25th to Sept. 27th, or eighteen weeks. This time is very naturally divided by the state of the weather and condition of the pastures into three periods. In the first period, extending from the beginning of the experiment to July 12th or seven weeks there was an abundant rain fall and the grass grew vigorously, affording a "full bite" all the time. The second period, from July 13 to Aug. 16 or five weeks, was characterized by hot weather and a severe drought, during which the pastures became very dry and bare and were supplemented with second growth clover. In the third period, from Aug. 17 to the end of the experiment, or six weeks, after copious rains the pastures rapidly recovered their luxuriance.

In Table II is shown the average daily milk yield of each lot, the average percentage of total solids and fats in the milk of each lot on three days of each alternate week, and the average amount of butter fat produced per cow per week by each lot. This last is found by multiplying the average milk yield for the week by the average per cent. of fat in the milk on three days of the week, except in the weeks when no analysis was made, when the average for the preceding and following weeks was used.

TABLE II.

Week Ending.	Yield of Milk. Average lbs. per day per cow for whole week — Lot I. Pasture	Lot II. Past. & Grain.	Per cent. total solids, average on three days of week. — Lot I. Pasture	Lot II. Past. & Grain.	Per cent. fat, average on three days of week. — Lot I. Past.	Lot II Pas. & Grain.	Average Lbs. of butter fat produced per cow per week — Lot I. Past.	Lot II Pas. & Grain.
May 24. (At begin.)	**28.84**	**28.55**	**13.74**	**13.34**	**3.83**	**4.19**	**7.74**	**8.38**
May 31 . .	30.37	31.12	14.04	13.53	4.31	4.35	9.16	9.48
June 7 . .	31.32	31.05	13.80	13.50	4.26	4.09	9.34	8.89
June 14 . .	30.43	30.43	. . .	. . .	*4.15	*3.80	8.83	8.09
June 21 . .	29.37	31.45	13.32	12.98	4.03	3.51	8.28	7.73
June 28 . .	30.01	29.71	. . .	. . .	*3.99	*3.54	8.37	7.36
July 5 . .	28.87	28.75	13.59	13.32	3.94	3.57	7.95	7.18
July 12 . .	26.87	28.04	. . .	. . .	*3.44	*3.38	6.47	6.63
Average 1st period.	**29.61**	**30.08**	**13.69**	**13.33**	**4.14**	**3.88**	**8.34**	**7.91**
July 19 . .	25.50	26.12	12.95	13.40	2.94	3.19	5.25	5.83
July 26 . .	23.17	25.06	. . .	. . .	*3.10	*3.08	5.02	5.39
Aug. 2 . .	21.89	24.43	13.43	12.69	3.25	2.96	4.98	5.08
Aug. 9 . .	20.74	24.04	. . .	. . .	*3.39	*3.21	4.92	5.39
Aug. 16 . .	18.79	22.84	13.25	13.11	3.53	3.45	4.64	5.52
Average 2d period.	**22.02**	**24.40**	**13.21**	**13.07**	**3.24**	**3.20**	**4.96**	**5.44**
Aug. 23 . .	18.56	21.92	. . .	. . .	*4.07	*4.11	5.29	6.58
Aug. 30 . .	18.46	21.59	13.29	13.63	4,61	4.76	5.95	7.20
Sept. 6 . .	18.62	20.62	. . .	. . .	*4.65	*4.56	6.05	6.58
Sept. 13 . .	18.32	18.82	13.41	13.44	4.68	4.36	6.00	5.75
Sept. 20 . .	16.28	18.20	. . .	. . .	*4.88	*4.31	5.56	5.49
Sept. 27 . .	17.13	18.65	14.69	13.71	5.07	4.25	6-08	5.55
Average 3d period.	**17.87**	**19.96**	**13.80**	**13.59**	**4.79**	**4.46**	**5.82**	**6.19**
Total amount of fat produced during exp't per cow, .							**118.14**	**119.72**

* Average of preceding and following weeks.

It will at once be seen that, as in 1889, we received no return in the production of butter fat from the grain fed. In the whole period we have 1.58 pounds per cow, or about four and three-quarters pounds in all to show for the consumption of 2822 pounds of wheat bran and cotton seed meal by Lot II. The manurial value of the grain fed and the saving in amount of pasture consumed by the grain fed cows would amount to considerable but

not enough by far to counterbalance the extra cost of the grain ration.

A difference will be noticed in the milk yield of the different lots in the two years. While in both years there was, as was to be expected, a continual decrease in the flow of milk, in 1889 the decrease in the grain fed lot was much greater and more rapid than in the lot that had only pasture; but in 1890, the decrease was much more nearly even and was slightly less in the grain fed lot.

There was also a difference in the varying percentages of fat in the milk of both lots in the two seasons that may be, and probably is, due to the difference in the state of the weather and the pastures. The season of 1889 was very wet throughout and the grass in the pastures never once lacked for water or ceased to grow, but the month of August was drier than any of the others and in this month the percentage of fat in the milk of both lots increased but much more in the grain fed lot than in those that had only pasture. In 1890 in the early part of the season the grass was fully as luxuriant as in the same period in 1889, but beginning a little before the middle of July a severe drought set in, accompanied by an appreciably higher temperature than any experienced in 1889. This drought lasted for about a month during which time the pastures suffered so severely that second growth clover had to be cut and carried to the cattle in the fields. During this period the fat in the milk of both lots ran down, but not so much in the grain-fed lot as in the other. When the rains came and the grass started up, the percentage of the fat in the milk rapidly ran up, but the grain-fed lot maintained the lead that they had secured during the drought.

It was urged by some who carefully studied the report of the experiments last year that the effect of a grain ration would probably be more marked with cows that had been poorly wintered and came into milk in the spring thin in flesh, than with our cows that are kept in good flesh all the year round. For this reason, two thin cows (No. 3 in each lot) were bought specially for this experiment. They were very much alike in general build and appearance, one was three and the other five years old, both had calved at about the same time and both were very thin in flesh. They were on the farm and fed in the stable the same as the other cows for a little more than a month before the experiment began.

The milk of these cows went with that of the others in making up the results given in Table II, but on one day of each alternate week a sample of the milk of each of these cows was taken and analyzed separately. In the following table the average results for the three periods for the single thin cows is shown in comparison with the results for the whole lot, as given in table II.

TABLE III.

	Yield of Milk Av. lbs. per day per cow whole week.		Per ct. total solids. Av. on three days of week.		Per cent. fat, average on three days of week.		Average Lbs. of butter fat produced per cow per week	
	Lot I Pasture.	Lot II Pas. & Grain.	Lot I Pasture.	Lot II Pas. & Grain.	Lot I Pasture.	Lot II Pas. & Grain.	Lot I Pasture.	Lot II Pas. & Grain.
At beginning.								
Av. of whole lot.	28.84	28.55	13.74	13.34	3.83	4.19	7.74	8.38
Single thin cow.	26.45	25.91	13.10	12.92	3.50	3.33	6.49	6.04
1st Period.								
Av. of whole lot.	29.61	30.08	13.69	13.33	4.14	3.88	8.34	7.91
Single thin cow.	30.78	24.96	13.19	13.36	3.42	3.37	7.32	5.74
2d Period.								
Av. of whole lot.	22.02	24.40	13.21	13.07	3.24	3.20	4.96	5.44
Single thin cow.	23.03	18.09	12.96	13.15	3.08	3.08	4.92	3.90
3d Period.								
Av. of whole lot.	17.87	19.96	13.80	13.59	4.79	4.46	5.82	6.19
Single thin cow.	20.65	14.72	13.81	13.40	4.48	4.10	6.32	4.09

	Lot I.	Lot II.
Average total butter fat produced per cow	118.14	119.72
Total butter fat produced by thin cow	113.79	84.27

It will be seen that not only did the thin cow fed on pasture and grain not yield more milk and butter than her companion that had nothing but grass, but in fact yielded considerably less. At the time that the selection was made it was thought that the former would in all probability be most likely to be favorably affected by the grain ration. She was the younger, rather the thinner, and seemed to have rather more vitality. For these reasons she was selected to receive the grain ration. She failed entirely to respond to the grain feed in milk and butter, but did gain considerably more in weight, as will be seen when we come to make a study of the changes in live weight.

This comparison shows the importance of numbers in eliminating individual peculiarities. While each lot as a whole produced almost the same amount of butter fat, in the separate members of each lot there were very considerable differences.

THE EFFECT ON THE LIVE WEIGHT.

The cows were at pasture both night and day. They were brought up about half-past four o'clock in the morning to be milked, and the grain fed lot then received their morning ration. On Thursday morning of each week the cows in both lots were weighed as soon as they were milked, and after those in Lot II had eaten their grain. Below is given the result of these weighings for each cow and the averages for each lot :

TABLE IV.

	Lot I. Pasture.				Lot II. Pasture and Grain.			
	No. 1. Glista Wt. Lbs.	No. 2. Cora. Wt. Lbs.	No. 3. Shadow. Wt. Lbs.	Average. Wt. Lbs.	No. 1. Jane. Wt. Lbs.	No. 2. Gem. Wt. Lbs.	No. 3. Phantom. Wt. Lbs.	Average. Wt. Lbs,
May 29	1050	1025	875	**983**	1130	865	615	**870**
June 5	1010	1030	890	**977**	1130	855	740	**908**
June 13	975	1040	905	**973**	1190	900	755	**948**
June 19	1050	1006	930	**995**	1175	890	774	**946**
June 26	1030	1040	940	**1003**	1205	894	785	**961**
July 3	1052	1032	965	**1016**	1226	916	782	**975**
July 10	1054	1008	950	**1004**	1190	902	814	**969**
July 17	1064	1018	954	**1012**	1213	876	818	**969**
July 24	1071	1035	955	**1020**	1208	920	818	**1015**
July 31	1072	1021	1009	**1034**	1211	904	822	**979**
August 7	1024	991	968	**994**	1192	882	815	**963**
August 14	1036	988	955	**993**	1185	890	850	**975**
August 21	1021	979	962	**987**	1149	875	823	**949**
August 28	1010	988	975	**991**	1160	879	840	**960**
September 4	1000	985	991	**992**	1200	872	820	**964**
September 11								
September 18	962	919	882	**921**	1227	831	786	**948**
September 25	963	932	942	**946**	1163	855	823	**947**
Gain + or loss −	−87	−93	+67	**−37**	+33	−10	+208	**+77**

The "thin cows," No. 3 in each lot, were the ones that made the largest gains, and the one in Lot II that had grain, gained much more than the one in Lot I that had none. Aside from these two cows there was very little variation in the weights of the two lots, what variation there was being in favor of the grain

fed lot. In most cases the total variation in weight during the course of the experiment was less than one hundred pounds.

THE EFFECT OF GRAIN WHEN COWS ARE SOILED.

Beside the experiment detailed above a similar one was carried on at the same time in which the cows were kept in the barn, and the grass cut and carried to them. For this experiment there were also two lots of three cows each, but the only cows available were those that had been in milk during the winter, and were due to calve again in the early fall. The lots were as follows :

LOT III—SOILED ON GRASS.

No. 1—Puss, ⅞-blood Holstein, five years old; dropped last calf Sept. 22, 1889; bred Nov. 8, 1889.

No. 2—Aggie, ⅞-blood Holstein, six years old; dropped last calf Sept. 25, 1889; bred Nov. 8, 1889.

No. 3—Pet, ⅞-blood Holstein, four years old; dropped last calf Aug. 29, 1889; bred Dec. 11, 1889.

LOT IV—SOILED ON GRASS AND GRAIN.

No. 1—May, ¾-blood Holstein, eight years old; dropped last calf Oct. 4, 1889; bred Jan. 12, 1890.

No. 2—Belva, ⅞-blood Holstein, three years old; dropped last calf Sept. 8, 1889; bred Nov. 7, 1889.

No. 3—Freddie, ¾-blood Holstein, four years old; dropped last calf Sept. 14, 1889; bred Dec. 5, 1889.

The experiment was begun on May 25th, up to which time both lots had been fed on hay and the same amount and kind of grain that Lot IV continued to receive, and lasted for five weeks. Each cow had furnished to her all the fresh cut grass, clover and timothy in about equal proportions, she would eat, in two feeds per day, and the cows in Lot IV had in addition 9 pounds each per day in two feeds of the same grain mixture that was fed Lot II, viz.: 200 pounds wheat bran, 150 pounds cotton seed meal, and 15 pounds malt sprouts. The other details of the experiment were carried out in the same manner as for Lots I and II.

In table V is shown the results of the feeding, in milk and butter :

TABLE V.

Week Ending.	Yield of Milk. Av. lbs. per cow per day for whole week. Lot III Cut grass.	Lot IV Cut grass & grain.	Per cent. total solids. Av. on three days of week. Lot III Cut grass.	Lot IV Cut grass & grain.	Per cent. fat. Average on three days of week. Lot III Cut grass.	Lot IV Cut grass & grain.	Av. lbs. of butter fat produced per cow per week. Lot III Cut grass.	Lot IV Cut grass & grain.
At begin'g May 24	**23.93**	**30.05**	**13.16**	**12.78**	**3.17**	**3.10**	**5.31**	**6.51**
May 31	21.89	31.15	13.61	12.94	3.46	3.20	5.30	6.98
June 7	21.30	31.80	13.53	12.90	3.60	3.33	5.36	7.42
1st Period. Average.	**21.88**	**31.48**	**13.57**	**12.92**	**3.53**	**3.27**	**5.33**	**7.20**
June 14	18.51	31.24	. . .	. . .	3.61	3.30	4.68	7.22
June 21	14.58	29.88	13.42	12.75	3.62	3.28	3.59	6.75
June 28	9.48	26.90	. . .	. . .	3.62	3.28	2.40	6.18
2d Period. Average.	**14.19**	**29.34**	**13.42**	**12.75**	**3.62**	**3.28**	**3.59**	**6.75**
Total am't of fat per cow produced during experim't,							**32.05**	**47.68**

The time was naturally divided into the two periods by the state of cut grass used. For the first two weeks the grass was tender and succulent. After that as it approached maturity it constantly became drier and harder. This is well shown in the amounts of grass eaten by the two lots during the experiment.

TABLE VI.

Grass Consumed—Pounds per Week.			
Week Ending	Lot III. Fed Cut Grass.	Lot IV. Fed Cut Grass and Grain.	Excess Consumed by Lot III
May 31	3163	2988	175
June 7	3211	3070	141
Average, 1st Period .	3187	3029	158
June 14	2796	2798	—2
June 21	2663	2660	3
June 28	1628	1629	—1
Average, 2d Period .	2362	2362	0

Thus we see that after the second week not only did the consumption of grass fall off rapidly, particularly in the last week,

but the relative amount consumed by the two lots changed greatly. In the first two weeks the cows that had nothing but grass ate, on an average, 158 pounds per week, or about 7½ pounds per cow per day more grass than the grain fed lot, while in the three following weeks the amount consumed was exactly equal in the two lots. Now turning to the table of production it will be seen that in the first period the cows that had no grain (Lot III) just about maintained an even milk and butter production, while the grain-fed cows (Lot IV) gained slightly, and consumed considerably less grass. In the last three weeks the cows that had no grain fell away rapidly in milk and butter yield, while the cows that had grain very nearly maintained their milk and butter yield, both lots consuming exactly the same amount of grass. In other words, when the grass was so succulent that the cows having no grain would eat more of it than those having grain, the milk and butter yield remained constant in both lots. When the grass became so hard that those having no grain would eat no more than the ones having grain, the grain fed lot forged ahead in milk and butter production. But in neither case was the grain fed at a profit, for in the first case a feed of nine pounds of an expensive grain mixture only resulted in a saving of 7½ pounds of fresh grass. And in the whole period Lot IV (grain fed) produced 47.68 pounds of butter per cow, as against 32.05 pounds for Lot III, during which time they consumed 963 pounds of grain. That is, there was received in the whole period not quite 47 pounds of butter fat to show for a consumption of 963 pounds of grain; but the grain fed lot were giving a little more than a pound of butter fat per cow per week at the beginning, which alone in the five weeks would account for 15 pounds of this difference. Perhaps the most marked effect in this trial was the way in which the grain fed cows (Lot IV) maintained their flow of milk, as the grass grew harder. This is the more noticeable from the fact that all the cows were far advanced in calf and close upon the time when they might be expected to rapidly decrease in milk yield.

CONCLUSION.—In two trials in two seasons we have received no return in milk and butter from feeding a grain ration to cows on good pasture.

In one trial with cows soiled on fresh grass we have received in increased milk and butter production and in saving of grass consumed, barely enough to pay for the cost of the grain ration added.

In neither case has any allowance been made for increased value of manure when grain is fed, which would be considerable in amount but exceedingly difficult to estimate with exactness.

We are still of opinion that several repetitions of this experiment will be needed before the matter can be considered conclusively settled.

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COLLEGE OF AGRICULTURE.

BULLETIN

OF THE

Agricultural Experiment Station.

ENTOMOLOGICAL DIVISION.

XXIII.

DECEMBER, 1890.

Insects Injurious to Fruits.

"That art on which a thousand millions of men are dependent for their sustenance, and two hundred millions of men expend their daily toil, must be the most important of all; the parent and precursor of all other arts. In every country, then, and at every period, the investigation of the principles on which the rational practice of this art is founded, ought to have commanded the principal attention of the greatest minds."—JAMES F. W. JOHNSTON.

PUBLISHED BY THE UNIVERSITY,
ITHACA, N. Y.,
1890.

CORNELL UNIVERSITY.

Agricultural Experiment Station.

Offices of the Director and Deputy Director, 20 Morrill Hall.

Those desiring this Bulletin sent to friends, will please send us the names of the parties.

Insects Injurious to Fruits.

I. INSECTS INFESTING THE PEAR.

THE PEAR LEAF BLISTER.

Phytoptus pyri.

Order ACARINA ; family PHYTOPTIDAE.

Reddish spots an eighth of an inch or more in diameter appearing on pear leaves in the spring, and changing to black corky spots in the autumn, each with a minute opening in it.

IN the Report upon the Condition of Fruit-growing in Western New York recently published by this station,* Professors Bailey and Dudley, while describing the scab fungi of apple and pear (*Fusicladium*), incidently refer to black, corky spots abundant on pear leaves and supposed to be produced by a gall mite. In fact Professor Dudley states that most of the diseased spots on the pear leaves that he has studied last season and this are of this nature, and that there are only occasional bunches of the scab fungus found in connection with them.

Since the appearance of this report, this disease of pear leaves has been carefully studied by the Entomological Department of the station ; and we give below a brief review of what has been learned regarding it.

The supposition that the disease is caused by mites has been proved to be correct, and a careful study of the spots on the leaves and of the mites that produce them shows that we have to do with a malady that has long been a scourge in Europe, but which has attracted but little attention in this country.

An excellent account of the disease, containing some important original observations, was published by Prof. T. J. Burrill ten years ago.† This is the only article on this subject worthy of

*Bulletin XIX, August, 1890.

†Gardener's Monthly and Horticulturist, Jan. 1880.

note that we have been able to find in American publications.* It is strange that so important a disease, and one so widely spread as this seems to be in this country, should have attracted so little attention here. In Europe, however, the disease has been very carefully studied and excellent accounts of it have been published. The most complete one that we have found is that given by Sorauer in his great work on the diseases of plants.†

Symptoms of the Disease.—Burrill and others state that when the young leaves appear in the spring or during the summer, reddish spots an eighth of an inch or more in diameter may be seen scattered more or less numerously over their surface; that these spots are especially conspicuous on the upper side of the leaves; but that at a later time the spots turn brown by the death of the parts, after which they are more easily discovered beneath.

FIG. 1.—*Cluster of infested leaves. a Upper surface of leaf; b lower surface; c two galls enlarged.*

Early in August, when we began our studies of the disease on some badly infested trees, no reddish spots were observed. The diseased parts were brownish or black, and had a corky appearance. These spots occur either singly scattered over the surface of the leaves, or are massed so as to form large blotches which often involve a large part of the leaf. (Fig. 1).

If these spots be examined from the lower side of the leaf with a microscope of low power, a good hand lens is sufficient, there

*Mr. H. Garman has published an excellent article on the general subject of the Phytopti and other Injurious Plant Mites in which there is a brief description of Phytoptus pyri by Professor Burrill, Twelfth Report of the State Entomologist of Illinois, (1883), p. 123–143.

†Dr. Paul Sorauer, Handbuch der Pflanzenkrankheiten, Erster Theil, s. 814–825.

can be observed near the centre of each a minute hole through the the epidermis of the leaf. (Two of these spots are represented enlarged at c. in Fig. 1.) This hole leads into a cavity within the substance of the leaf; and in this cavity reside the mites that cause the disease.

Minute Structure of the Leaf Gall.—The diseased parts of the leaf within which the mites live may be termed galls, as are the various abnormal vegetable growths produced by true insects.*

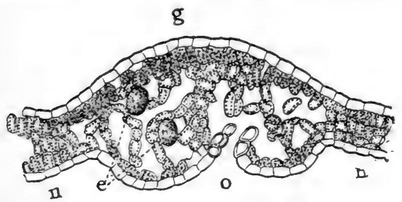

Fig. 2.—*Section of leaf. g. Gall; n.n. normal structure of leaf; o. opening of gall; e. eggs, after Sorauer.*

These galls, or blisters, as they are sometimes termed by gardeners, are swellings of the leaf, within which there is a cavity affording a residence for the mites. Fig. 2 represents a section of a leaf through one of these galls. Here the leaf is seen to be greatly thickened at the diseased part. On the lower side there is an opening through which the mite that started the gall entered, and from which young mites developed in the gall can escape, in order to start new galls. In addition to the swelling of both surfaces of the leaf its internal structure is seen to be modified. In some parts there is a great multiplication of the cells, and in others a large part of the cells have been destroyed. Two eggs of mites are represented in this gall (*e*).

As the season advances and the galls become dry and brownish or black, the thickening of the leaf becomes less marked. In

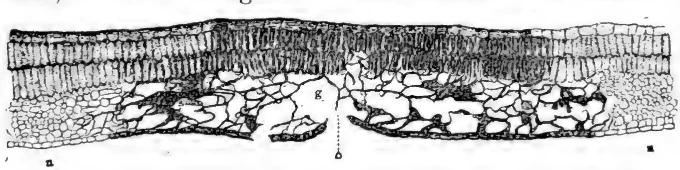

Fig. 3.—*Section of leaf showing structure of gall in autumn. g. Gall; n. uninjured part of leaf; o. opening of gall.*

fact in some cases there is a shrinkage of the parts affected. Fig. 3 represents a section through a leaf collected and studied in October.

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*Many writers apply either the term *cecidia*, or *acarocecidia* to galls produced by mites; but we do not see the necessity for this multiplication of technical terms. The same writers refer to diseases of plants caused by mites as *acariasis*, or if produced by gall mites (Family *Phytoptidæ*) the disease is termed *phytoptosis*.

Appearance of the Mite.—As already stated the mite that causes the Pear-leaf Blister is well known in Europe from whence it has doubtless been imported on nursery stock. It is an exceedingly small creature, being practically invisible to the unaided eye; and even with a good hand lens it appears merely as a minute white speck. In fact, the best of microscopes is necessary in order to study its structure satisfactorily. The entire length of the body is about one one-hundred-and-fiftieth of an inch; and the width about one-fourth as great. The body is cylindrical in form, tapering slightly towards each end. (Fig. 4.) It is ringed throughout the greater part of its length with very fine rings. Sorauer states that from 50 to 80 of these rings can be counted; but we find the number much greater. Fig. 4 was engraved from a photograph, and represents quite accurately the rings of the specimen studied. As with other members of the family to which this mite belongs, there are only four legs. These are placed near the head end of the body, so that when the animal walks it drags its body after it. The head is in the form of a conical snout, within which are two sword-like jaws. The body and legs are furnished with a few hairs which are constant in number and position; these are represented in the figure.

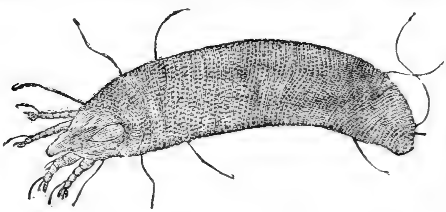

FIG. 4.—*Phytoptus pyri.* *Adult mite.*

Life History of the Species.—The eggs are laid by the females within the galls that they have formed, and here the young are hatched. How long the young remain within the gall of their parent has not been ascertained; but sooner or later they escape through the opening in it, and seeking a healthy part of the leaf work their way into the tissue, thus starting a new gall. By this spreading of the young from the galls in which they have hatched and starting new ones, the number of galls on a tree may become rapidly multiplied. The mites live within the galls till the drying of the leaves in the autumn; then they migrate to the leaf buds at the ends of the twigs; where after working their way beneath the leafy scales they remain throughout the winter.

The mites instinctively make this migration as soon as the leaves become dry. We found that whenever branches were

brought into the laboratory for study, as soon as the leaves began to dry, the mites left them and gathered in great numbers in the buds.

Means of Destroying the Mites.—Owing to the fact that the mites live within the tissues of the leaves they are beyond the reach of ordinary insecticides. It is obvious that they would not be affected by any poison dusted or sprayed upon the surface of the leaves. We conducted a series of experiments to ascertain if the mites could be reached by an application of kerosine emulsion. It was hoped that a sufficient quantity of the liquid would pass into the galls through their open mouths to injuriously affect the mites. But we obtained only negative results. Infested branches were sprayed; later when they were brought into the laboratory and the leaves became dry the mites emerged from the galls in apparently as great numbers as from branches that had not been sprayed.

There seems to be only a single point at which the mite can be attacked, this is in its winter quarters. As the mites collect in the terminal buds in the autumn and remain there during the winter, by carefully pruning and burning the young wood they can be destroyed. This would be a simple matter in case of young trees. But if the infested trees be large ones, the labor would be considerable, still no one has been able as yet to suggest a less laborious method.

The pruning should be supplemented by a careful burning of the fallen leaves and other rubbish in the orchard; as some of the mites being tardy in seeking their winter quarters in the buds may be carried to the ground with the falling leaves. And as a last precaution the trees should be examined soon after the leaves appear the following spring; and if any of the leaves show the redish spots characteristic of this disease, such leaves should be removed and destroyed. It is probable that even with the most careful pruning and burning a few mites will escape. But by destroying them in the way indicated, as soon as they begin to form galls, the cure will be complete.

This is one of those cases where if it is worth while to do anything it will pay to be very thorough. For if an infested orchard be once freed from the pest, there is but little danger of its appearing again, as the mites have very limited powers of spreading.

A STAG-BEETLE BORER IN PEAR.

Dorcus parallelus.

Order COLEOPTERA ; family LUCANIDAE.

A white grub resembling in form the larva of the May-beetle, boring into the roots of pear, and finally transforming into a stag-beetle measuring seven-eighths inch in length.

THE stag-beetles are well-known insects in the adult form ; the large size of some of the species and their prominent toothed jaws resembling the horns of a stag, render them conspicuous. Comparatively little, however, is known regarding the habits of their larvæ. And it is to put on record a newly ascertained fact regarding one of them that this note is written.

The adult beetles are found on the trunks of trees, and are said, by Harris, to live upon the sap, for procuring which the brushes of their jaws and lips seem to be designed. They lay their eggs in crevices of the bark of trees, especially near the roots. The larvæ that hatch from these eggs resemble the well known white grub (the larva of the May-beetle) in form. But unlike the May-beetle larva which feeds on the roots of herbaceous plants, the larvæ of the stag-beetles bore into the solid wood of the roots and trunks of trees, and reduce it to a substance resembling very coarse sawdust. They mature very slowly ; it is said that the larvæ of some of the larger species require six years to complete their growth.

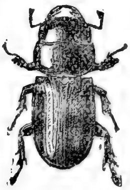

FIG. 5.—*Dorcus parallelus.*

Dorcus parallelus (Fig. 5,) is a stag-beetle of medium size that occurs in the states on the Atlantic seaboard. Its larva is said to live in lime trees and sugar maple ; but no mention of its being an enemy to fruit trees has been published heretofore. During the first week of September I received the specimen which the accompanying figure represents natural size, from E. A. and H. N. Hoffman, of Elmira, with the following statement regarding it : "The beetle was found in the roots of an old pear tree, where it had eaten off one of the branch roots, which was about two inches through, and the tap-root which was nearly three inches through, and was eating upwards in the tap-root when discovered. The tree was beginning to die, which caused us to investigate it. There was about a handful of borings with the beetle when it was found."

From this experience it is evident that this species should be added to our list of injurious fruit insects. Unfortunately, in the

present state of our knowledge no mode of preventing the ravages of this pest can be suggested except the destruction of each individual that is found.

II. INSECTS INFESTING THE APPLE.

THE APPLE BUCCULATRIX.

Bucculatrix pomifoliella.

Order LEPIDOPTERA ; family TINEIDAE.

Small white cocoons, ribbed longitudinally, and occurring abundantly side by side on the lower surface of the twigs of apple trees. Fig. 6.

IT is evident that this pest of the apple is becoming very abundant in certain parts of this state. We have received during the past year many inquiries regarding it ; and the specimens that have been sent us show that the insect is present in great numbers where they were collected.

FIG. 6.—*Twig of apple with cocoons of Bucculatrix.*

A short account of this insect was published by Clemens twenty years ago ;* and many other articles concerning it have appeared in various publications since that time. But the most careful study that has been made of the species was conducted by Dr. A. E. Brunn in 1882 while a student in this department of Cornell University. The results of Mr. Brunn's studies were published by this station ;† but the report containing them is now out of print. It seems best, therefore, considering the importance of the subject and the interest that is felt in it, to give in this place a short review of what is known regarding it. The accompanying figure has been prepared especially for this Bulletin.

The larva and adult of this insect are minute creatures, and ordinarily escape observation. But the cocoons

* Proceedings of the Academy of Natural Sciences of Philadelphia, 1860, p. 211.

† Second Report of the Cornell University Experiment Station, 1883, p. 157–161.

being snowy white and occurring massed in great numbers on the twigs of the apple trees readily attract attention. Fig. 6, which was engraved from a photograph of natural size, gives the characteristic appearance of a twig bearing these cocoons.

The cocoons are from one-fourth to five-sixteenths of an inch in length, and about one-eighth as wide. They are cylindrical in outline, tapering but slightly towards the ends. They do not end sharply; but a delicate web of silk is continued over the twig for some distance beyond the end of the cocoon proper.

Within this cocoon the insect remains throughout the winter in the pupa state. In early spring, at the time the leaves expand, the pupa works its way partially out from the cocoon, and then changes to a moth, the empty pupa skin remaining attached to the cocoon by the caudal end which is never withdrawn from the cocoon; several such projecting pupa skins are represented in our figure.

The moth measures from the tip of its head to the end of the wings when they are folded at rest only about one-seventh of an inch (3.5 mm.).

This moth can be recognized by the following characters: The head is very pale ochreous, and bears a prominent tuft, which is tipped with brownish. The antennae are pale ochreous, and are dotted above with dark brown. The fore wings are whitish, tinged with pale yellowish, and freely dusted with brown. On the middle of the inner margin of each there is a large, dark brown, oval patch; the two form when the wings are closed a conspicuous, nearly round, dorsal patch. There is also on each fore wing a dark brown streak, arising from the costa opposite the oval patch just described, and extending to the inner angle of the wing. This patch is broadest on the costa and tapers towards the other extremity. At the tip of the wing there is a dark brown apical spot, and in the fringe of the wing, an outer marginal line. The hind wings are pale, brownish ochreous.

Soon after the moths emerge from the pupa state, they pair and lay their eggs. These are oval in outline, and of a greenish color, which is identical with that of the leaf. Their color and small size, they being only about one one-hundredth of an inch in length, render them very inconspicuous. The width of the egg is a little more than half the length, and the surface of the shell is rough and iridescent. After the egg is hatched the shell collapses and turns black.

The spring that this insect was studied here was a cold one; the average of the mean daily temperature from May 21st to June 21st being 61° F. It was probably due to this fact that the eggs did not begin to hatch till after the middle of June, which was a month after the moths had been observed to pair.

The larval history of this species is an unusually interesting one. It was first traced out by Mr. Brunn; and I cannot do better than to give it in his own words:

"The greenish colored eggs are laid scattering on the under surface of the leaf. The eggs commenced to hatch June 16 or 17, and the larva bored directly from the egg to the upper surface of the leaf, where they made a small brown serpent mine. After the larva leaves the egg the shell collapses and turns black. If the egg shell be removed the circular opening made by the larva entering the leaf can be seen. The mine is usually but 1 mm. ($\frac{1}{25}$ in.) broad at its largest end. Where the mines are abundant on the leaf, it turns yellow and dies. On a small leaf I have counted twenty or more mines. The frass is deposited along the middle of the mine. When the larva has made a mine from ½ to ¾ in. long, which it does in from four to five days, it eats its way out through the upper surface, then somewhere on the upper surface of the leaf it weaves a circular silken covering about $\frac{1}{12}$ in. in diameter. Stretched out on this network, the larva which is now 2.6 mm. long, makes a small hole in it near its edge, then, as one would turn a somersault, the larva puts its head into this hole and draws its body after. Arriving inside the *molting cocoon* as it may be termed, on its back and doubled in the shape of a horseshoe, the larva is then ready to strengthen the cocoon and close the opening which it made in entering. The larvæ make these cocoons in from fifteen to thirty minutes; and usually within a couple of hours after leaving the mine. After the desertion of the mine and before the making of these cocoons, the larvæ eat nothing, but may be found crawling over the leaves, stems and branches, and often suspended by silk threads. On the 24th of June many of the cocoons were empty, the larvæ having molted, leaving their cast-off skins in the molting cocoons and cut their way out. The larvæ remain in these cocoons in most cases less than twenty-four hours. The larva before molting is readily distinguished from its later stages by its yellow color and a large black spot on its first thoracic segment. After molting the first time the larva becomes dark green and has a number of small black spots on the first thoracic segment.

After leaving the cocoon it commences to feed externally, crawling everywhere and often suspended from the leaves by a silk thread. While feeding it lies stretched out at full length on the upper surface of the leaf, eating the upper epidermis and parenchyma in small patches, but leaving the lower epidermis

which turns brown. A few days after the larvæ left their molting cocoons, I observed a few quite large molting cocoons. Suspecting that they might be cocoons in which the larvæ molted the second time, as the larvæ within them were greenish and not yellow, I placed some of the yellow larvæ, which had just left their mines, in a bottle with fresh apple leaves. After making molting coooons and molting, they fed for two and a half or three days and then made a second cocoon which differed from the first only in size, being about 1/8 in. in diameter. These second cocoons are made and entered the same way as the first ones, and the larva remains on its back inside them for two days, when it forces its way out, leaving its second cast-off skin in the cocoon, and goes on feeding as before. The only subsequent molt is when the larva transforms to a pupa."

The larval state lasts about three weeks. When full grown the larvæ migrate from the leaves to the lower side of the twigs where they spin their cocoons. When the trees are badly infested these cocoons occur in great numbers massed side by side so as to nearly completely cover the lower surface of the twigs.

The duration of the pupa state of the spring brood is only about a week, the moths beginning to emerge soon after the middle of July. The subsequent history of the species has not yet been traced. Hence we do not know whether this spring brood is followed by more than one brood or not. The cocoons of the autumn brood were found in the latter part of September. As the spring brood requires only a month to pass through the larval and pupal stages, it seems probable that between the middle of July and the latter part of September there would be sufficient time for the development of two broods, thus making the species three brooded in this latitude.

While the duration of the pupa state of the spring brood is only a single week, that of the autumn brood is much longer, lasting from the middle or the latter part of September to the following April or May, between seven or eight months.

Method of Treatment of the Pest.—As this insect is rare at Ithaca, we have been able as yet to try only a few experiments in the destruction of it. Infested twigs sent us by several correspondents have furnished the material for these experiments.

The fact that during the winter the cocoons of all of the individuals infesting a tree can be found exposed, chiefly on the lower surface of the twigs, naturally suggests this point of attack. A liberal pruning and burning of the infested twigs would do

much to reduce the numbers of the pest. Our experiments on many infested branches show that those not reached in this way, that is the pupæ in cocoons attached to the larger branches and to the trunk, can be destroyed by the application of a strong kerosene emulsion, about one part of the emulsion to two or three parts of water. The pupæ are destroyed by the oil which soaks through the cocoons. A weaker emulsion failed to penetrate the cocoons. But a small amount of pure kerosene applied in a fine spray killed every pupa ; and as the oil evaporated in a few hours, it is qnite probable that the dormant wood was not injured. Still I am unwilling to advise the use of kerosene in this way before trying further experiments. And I believe that a more practicable method of fighting the pest is suggested by the fact that during the greater portion of its larval existence it feeds exposed on the surface of the leaves. If therefore the infested trees be liberally sprayed with Paris green water during the latter half of June the larvæ will be poisoned.

III. INSECTS INJURIOUS TO CHERRY.

THE CHERRY-TREE TORTRIX.

Cacoecia cerasivorana.

Order LEPIDOPTERA ; family TORTRICIDAE.

Large nests, each formed by fastening together with silk all of the leaves and twigs of a branch of choke-cherry or sometimes of cultivated cherry, and containing active yellow larvæ, which develop into brownish moths in July.

IN June and July there are often found on choke-cherry and sometimes also on the cultivated cherry, large nests at the ends of the branches, of the form shown in Fig. 7. Each of these nests is formed by fastening together with silk all of the leaves and twigs of a branch. Within this nest there lives a colony of larvæ, feeding on the inclosed leaves This colony consists of all of the offspring of a single moth, which working together make a common nest. The larvæ when full-grown measure about five-eighths of an inch in length. They are lemon yellow in color, and clothed with a very few fine yellowish hairs. The head, a shield on the

next segment of the body, and a similar shield on the last segment, and the six true legs are black, and the mouth parts brown. The larvæ mature early in July and transform to pupae within the nest. If the nest be opened at this time, there will be found in its interior large black masses of the excrement of the larvæ, and within these are the cocoons containing the pupae. The insects remain only a short time in the pupa state, the moths emerging during July. When the pupae are about to change to moths they work their way out of the nest clinging to it only by the hooks at the anal end of the body. And here they transform, leaving the empty pupa skins projecting from the nest as shown in the figure. The moths vary in size, the wing expanse of those we have bred ranging from four-fifths of an inch to nearly one and one-fifth inches. The wings are bright ochre yellow; the front pair marked with irregular brownish spots and numerous, transverse bands of a pale leaden blue. These markings vary greatly in different specimens. There are usually two brown spots, more or less divided with lead color, on the fore (costal) edge of the wing, and three or more similar spots on the disc of the wings; in addition to these there are a number of brown dots on the costal edge and on the disc. (Fig. 8 and 9.)

FIG. 7.—*Nest of Cacoecia cerasivorana.*

FIG. 8.—*Cacoecia cerasivorana, male.*

FIG. 9.—*Cacoecia cerasivorana, female.*

We did not observe the eggs, neither have we been able to find any published account of them. They are probably laid in a cluster on a twig near the end of a branch. The gregarious habits of the larvae indicate that the eggs are not scattered; and as the moths appear so early in the season it is probable that the species winters in the egg state; in which case the eggs cannot be laid on the leaves, as then they would fall to the ground and the larvae would not appear in colonies at the tips of the branches.

This insect is very subject to the attacks of parasites. From a single nest from which we bred only sixteen moths, there emerged eighty-seven Ichneumon flies. It is evident that in this case the majority of the larvae were destroyed by the parasites. This is probably the reason that the species is kept tolerably well in check in most parts of the country.

In case this insect becomes destructively abundant, it can be easily checked by cutting out the nests and burning them before the moths emerge. As the insects reach maturity in July, some of them early in that month, the destruction of the nests should be done not later than the last of June.

THE CHERRY-TREE SCALLOP SHELL MOTH.

Hydria undulata.

Order LEPIDOPTERA; family GEOMETRIDAE.

In July and August, fastening together the leaves of the ends of the branches of the cherry, more often the wild cherry, and feeding within them colonies of small measuring worms, each with four white stripes on a black ground above, and flesh colored below.

In July and August the terminal leaves on the outer branches of cherry trees, both the cultivated and wild species, but more frequently the latter, are often found curiously fastened together with their upper surfaces turned inward, and with several of the lower leaves drawn down and securely fastened at their edges over the leaves just above by many silken threads. Each leaf is so fastened as to present an outward convex surface, thus leaving an inner cavity which forms a nest or home within which the larvæ that made the nest live. These larvæ hardly ever appear on the outside of their home except when a new leaf is to be attached to it. The larvæ feed entirely on the pulp of the leaves and their upper skin, which has now become the inner surface of the nest, leaving the framework of veins and the lower skin of the leaf; these continue to constitute a secure wall to the nest. As more food is needed the lower leaves are drawn down one after the other and tied to the nest; until in some instances, where there are many larvæ in the nest, these narrow bags or nests attain a length of from one to two feet. The first leaves die and become

brown as the other leaves overlay them, and thus make the nest more conspicuous. A small nest is shown, somewhat reduced in size, in Fig. 10. The number of larvæ which occupy these nests varies greatly, some nests containing but 15 or 20 while others have nearly 100 larvæ in them. A full grown larva measures about three-fourths of an inch in length. The upper surface of the body is black, marked with four narrow, parallel, white stripes ; the sides and lower surface of the body are flesh colored, marked by several narrow, paler stripes. The head is light yellowish brown in color, and on the back of the segment next to the head, is a dark brown shield. The tips of the mandibles or jaws, a shield on the back of the last segment of the body, and a large spot on the upper side of the last pair of pro-legs, are black. The body, including the head, is sparsely covered with short, brownish hairs that arise from small, black spots, which are quite conspicuous on the sides and ventral surface of the body. Two pair of prolegs are present, borne by the 6th and last abdominal segments.

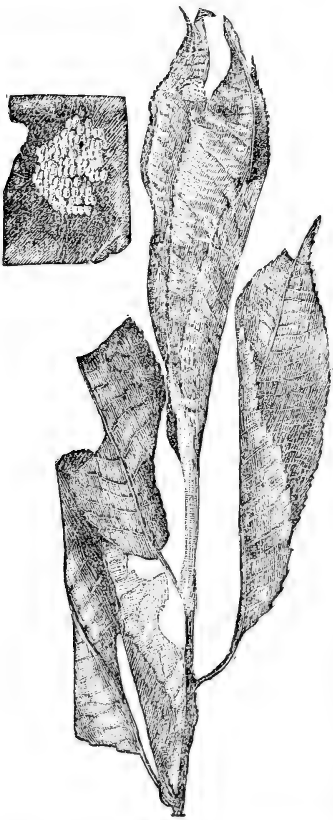

Fig. 10.—*Nest of Hydria undulata.*

Most of the larvæ reared in the nsectary matured in September, left the nest, and crawling under leaves on the surface of the soil or descending for a short distance into the soil, made slight cocoons of particles of sand fastened together with silken threads. Within these cocoons the larvæ changed to pupæ in a few days. The pupa measures four-tenths of an inch in length and twelve one-hundredths of an inch in width. It is of a glossy chestnut-brown color, with the abdominal segments coarsely punctured, and with the last segment extended into a slender two-parted curved hook. The adult insects do not appear till the following summer, generally during the latter part of July, al-

though two moths appeared in our breeding cages as early as the last of May. This was doubtless due to the pupae having been kept abnormally warm during the winter.

The moths have a slender brownish body and vary considerably in size, measuring across their extended wings from 25 mm. (1 inch) to 38 mm. (1.50 inches). Nearly the whole upper surface of both pairs of wings are occupied with numerous narrow, wavy and zigzag lines, alternately of a whitish and a dark brown or blackish color. On many of our bred specimens there is a wide dark brown band across the middle or disc of the fore wings, caused by the brown lines on that part being considerably darker than elsewhere on the wing. Near their outer margins, both pairs of wings are of a butternut-brown color and traversed by a distinct whitish zigzag line. Beneath, the wings are of a fawn-brown color with the lines more or less obsolete and the black discal spots large and distinct. The moth (Fig. 11) is known to collectors as the Scallop Shell, from its resemblance to the ribbed shell thus named.

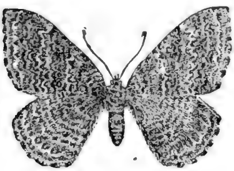

FIG. 11.—*Hydria undulata.*

The female, soon after emerging and pairing with the male, lays her small, whitish eggs in an irregular cluster on the lower side of one of the leaves near the end of a branch. It is here that the larvæ make their nest. On the nest near the top of Fig. 10 is shown a cluster of the eggs about one-half natural size, and in the position it occupied when the nest was found. After the larvæ have escaped, these egg-clusters are easily detached, which may account for their not being found on all of the nests. Each cluster contains from one hundred to two hundred eggs arranged in three or four layers. The egg is oval in form with a depression on the upper and lower side, and measures two one-hundredths of an inch in length and is three-fourths as wide as long. A cluster of the eggs, much enlarged, is represented in the upper part of Fig. 10.

This insect, like many of our insect pests, has its natural enemies which materially lessen its destructiveness. From nearly every cluster of eggs found, we have bred many minute Chalcid flies. Only the upper layer of eggs was parasitized, the little Chalcid seemingly not being able to reach the lower two or three layers to complete its good work. However, those larvæ that, in their egg state, escape the busy ovipositor of this little Chalcid and emerge

safely, cannot feel secure even in their tight home; for a little Braconid fly, less than an eighth of an inch in length, instinctively enters the nest and deposits its eggs in their helpless bodies. During the latter part of August we found in the nests many of the little white cocoons spun by the larvæ of these Braconides, still attached in some cases to the dead and shriveled body of their victim. From many of these cocoons the adult Braconids soon emerged through little circular doors cut from one end of the cocoon; but in some cases, from an irregular hole made in the side of the cocoon, there emerged a Chalcid fly of about the same size as the Braconid. This Chalcid fly is no doubt a secondary parasite which preys upon the parasitic Braconid larva.

Notwithstanding the number and activity if its little foes, this cherry tree pest, Hydria undulata, has become so numerous in a grove of small trees, mostly wild cherry, near the insectary that during the past summer the beauty of many of the cherry trees was seriously marred and their growth no doubt considerably checked. The remedy is simple and easily applied. Our experiments in the insectary supplemented by field observations indicate that the insect is single brooded in this state, and that most the larvæ leave the nest during the month of September, so that if the branches containing the nests be cut off and burned prior to Sept, 1, the pest will soon be exterminated.

As this insect sometimes attacks the cultivated cherry and is widely distributed; and as the literature relating to it is scanty and not accessible to most of the fruit growers of this state, it has seemed desirable to record our observations on the pest and thus acquaint the fruit growers with the nature of its work and the means of combatting it, should the insect make its appearance in their orchards.

DESCRIPTION OF THE LARVA OF HYDRIA UNDULATA.

LARVA.—Length, 19 mm. Width, 2 mm. General color, brownish-black striped with white above, flesh colored below. Head, light yellowish brown and sparsely hairy; tips of mandibles, anal shield, and a large spot on the dorsal surface of the anal pro-legs, black; thoracic shield, dark brown. On the dorsal surface of the body there are four narrow, distinct, whitish stripes extending from the pro-thoracic shield to the anal shield. The edges of these stripes are much indented, often appearing like a series of more or less closely united spots. A similar substigmatal stripe separates the dark dorsum from the flesh colored venter. Just ventrad of the spiracles there is a

narrow yellowish, white stripe; and three similar, somewhat broken stripes extend along the venter. There are many small, slightly elevated, black spots on the body, from which arise short brownish hairs. Near each spiracle there are three of these spots; one in the yellowish-white stripe just ventrad of the spiracles; one in the edge of the dark portion of the dorsum, and the third spot slightly caudad or caudo-ventrad of the spiracle. The dorsal surface of each segment bears four of these spots; on the thoracic segments and the anal segment they are arranged in a row across the middle of the segment, but on the remaining eight abdominal segments the four spots are arranged at the angles of a square. On the ventral surface of the thoraic segments and the eighth abdominal segment there are six spots arranged in a row across the middle of the segment, the two inner spots being quite near each other. Across the middle of the ventral portions of the first and seventh abdominal segments there is a row of eight spots, and on the anal segment there are four spots similarly placed. The ventral portions of the second, third, fourth, and fifth abdominal segments bear ten spots each, arranged as follows:—four spots margined with a yellowish-white ring, two each side on a fold of the body just ventrad of the yellowish-white stripe below the spiracles; three spots on each side of the mesal line and arranged at the angles of a triangle. The sixth abdominal segment has four of these spots on its ventral surface, two near the base of each pro-leg. Two pairs of pro-legs are present, borne by the sixth and last abdominal segments. The true legs and pro-legs are sparsely hairy and nearly the same color as the venter. Spiracles, black with brownish centre, the one on the prothoracic segment being the largest.

IV. INSECTS INJURIOUS TO CURRANT.

A LEAF-ROLLER ON CURRANT.

Cacoecia rosana.

Order LEPIDOPTERA; family TORTRICIDAE.

A small green worm fastening together the terminal leaves of currant into an irregular shaped wad, within which it lives and undergoes its transformations.

IN addition to the common, well-known pests of the currant, several species which infest that plant but are found less frequently, are being studied at this station. One of these is a common European moth known to entomologists as Cacoecia rosana. This insect has been introduced into this country; and judging from the number of specimens of the adult moth that are found in various collections, the species is common here in some places. But

no observations on the habits of the species have been recorded in this country. In Europe the larva is known to feed on the leaves of many trees and shrubs, but it has been observed in this country only on currant. It, however, doubtless feeds on several other plants.

The eggs were found at Albany, on Black Currant by our State Entomologist. As Dr. Lintner did not recognize them, they were sent to the writer in the hope that I might know them ; but they were equally strange to me. Fortunately the eggs soon hatched ; and I was able to follow the life history of the species in our insectary.

The eggs are very minute each one measuring only about .027 inch in diameter. They are scale-like in form ; and are laid in a mass overlapping each other. The mass is flattened oval in outline and contains about twenty-five eggs ; it measures in its greatest diameter one-sixth of an inch. It is represented in Fig. 12, enlarged. The specimen was figured after the larvæ had hatched ; and the openings in the eggs from which the larvæ escaped are shown in the figure.

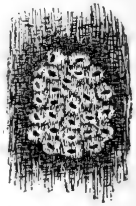

FIG. 12.—*Eggs of Cacoecia rosana, enlarged.*

The larvæ emerged from the eggs during the last days of April. At that time the leaves of currant were just expanding, the largest measuring one inch across. As no Black Currant, the plant upon which the eggs were found, was at hand, the larvæ were placed on the common red currant. They were perfectly contented, showing that the species will readily infest this plant.

The young larvæ seek the ends of the branches of the plant upon which they are. Here they begin to feed either in the terminal bud or in a crease in a leaf. In the latter case, they spin a silken bridge roofing in this furrow in which they live singly for a time. Later when they have increased somewhat in size, each larva fastens together the terminal leaves of a twig into an irregular shaped wad, about which it spins considerable silk. Within this wad the larva lives feeding on the inclosed leaves. Still later when the larva has become nearly full-grown it sometimes rolls a large leaf into a tubular nest as shown in Fig. 13.

The larva does not leave its nest to undergo its transformations, but changes to a pupa within the folded or rolled leaves. When

the pupa is about to change to an adult it works its way nearly out of the nest, only the caudal end of the body remaining within the folds of the leaf. This end of the body is armed with several hooks which the pupa fastens into some of the threads of silk spun about the nest, thus securely anchoring itself in place. Then the moth emerges leaving the empty pupa skin clinging to the nest.

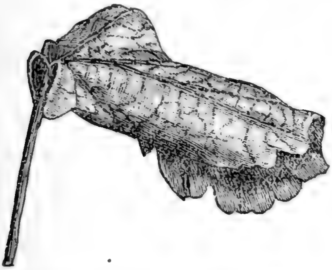

FIG. 13.—*Cacoecia rosana.*

The period required for this insect to get its growth and undergo its transformations after leaving the egg is a little more than a month. The eggs hatched during the last days of April (April 27–28). Some of the larvæ had reached the last larval stage by the middle of May. While others were not more than half grown at this time. The first pupa was observed May 22d ; and within a week all of the larvæ had transformed to pupæ. The moths began to emerge June 3d.

Eggs were not obtained from the moths that we bred ; consequently only one generation was observed. It is probable, however, that there are two or more broods each season. The time at which the eggs were found shows that the species passes the winter in this form.

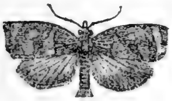

FIG. 14.—*Cacoecia rosana.*

The adult (Fig. 14,) is a moth with a wing expanse of three-fourths of an inch. The fore wings are olive brown crossed by bands of darker color. The hind wings are dusky.

Probably the most practicable method of destroying this insect, should it become a serious pest, would be the careful pruning and burning of the infested leaves and twigs. As the insect is concealed in the rolled leaves during its larval existence, the application of arsenical sprays would probably be of little use.

V. INSECTS INJURIOUS TO THE BLACKBERRY AND RASPBERRY.

A BLACKBERRY CANE-BORER.

Oberea bimaculata.

Order COLOPTERA; family CERAMBYCIDAE.

A footless grub, resembling in form the Round-headed Apple-tree Borer, boring in the canes of blackberry and raspberry, and transforming into a narrow-bodied, long-horned black beetle, with a yellow prothorax.

IN the latter part of July, two years ago, Professor Caldwell drew my attention to an extensive destruction of blackberry canes, at his summer residence, near Kidders, on the shore of Cayuga Lake. At that time the leaves on many of the bearing canes were observed to be dying, and the fruit, which was not yet mature, to cease its growth. An examination of the diseased canes revealed the presence in each of a boring grub, the cause of the injury.

At the time of this observation five per cent. of the canes were found to be destroyed by this borer. And as the infested canes were only just beginning to die, some of them were not detected at that time; thus the injury was even greater than five per cent. of the crop. Although the infested canes produce fruit, it does not ripen, as the canes die before it matures.

The boring larvæ were found only in the bearing canes. They are cylindrical, footless, yellowish grubs, measuring about three-fifths of an inch in length. When first observed in the latter part of July they had made in each case a burrow less than two inches in length; but after that date the burrows were rapidly extended downward so that they became in many cases two feet or more in length and reached the base of the canes. The burrows are about one-eighth of an inch in diameter; they wind from side to side of the pith, and at frequent intervals penetrate the woody part of the cane. In some of the cases where the woody part of the cane is penetrated an opening is made through the bark. These openings occur at intervals of a few inches throughout the length of the tunnelled portion of the cane; they are small, being about

one-third of the diameter of the burrow ; and their object is to enable the larva to deposit its excrement outside of the burrow. It is evident that the larva puts the candal end of the body at this opening and forces the excrement directly into the open air, for it was found in long strings, some of them a half inch in length, on the sand below the openings ; and the burrows were always free from it.

An examination of some of the canes in our breeding cages made in the last half of September showed that the borers were still in the larval state. But they had penetrated the canes to the bottom where the cut ends were inserted in the sand of the cages. From this I inferred that normally the grubs work their way into the root of the cane before transforming, and that they reach the root early in the autumn. Later when the species was determined I found that the fact of its wintering in the roots of the infested plants had been recorded.

FIG. 15.—*Oberia bimaculata.*

The insect remains in the roots till the following summer when it emerges as a long-horned, slender-bodied beetle about a half inch in length. It is of a deep black color except the segment next the head, the prothorax, which is yellow. There are usually two or three black spots on the upper part of this segment, but frequently these are wanting. (Fig. 15.)

Although I can find no account of this insect infesting blackberry canes to the extent which we observed, it has long been known as a pest in raspberry plantations ; and its peculiar method of oviposition has frequently attracted attention.

The eggs are laid in the early summer, usually during the month of June. They were not observed in the blackberry ; but when the insect infests raspberries the first indication of the injury noticed is usually the withering and drooping of the ends of the young shoots. If these be examined there will be found at the base of the wilted portion two rows of punctures encircling the cane about half an inch apart, and between them a small hole in which an egg has been deposited. This double girdling of the cane is done by the beetle with her jaws at the time she lays her egg. It has been suggested that the purpose served by this girdling is the arresting of the circulation of the sap in this part of the cane ; and in this way the prevention of the crushing of

the tender egg by a vigorous and rapid growth of the tip of the cane.

The methods of combatting this insect are simple but they require prompt attention. As soon as the tips of the canes begin to droop they should be cut off below the point were they are girdled. In this way be larva can be destroyed before it has begun to bore into the lower portion of the cane, and thus only the tip of the cane will be lost. When, however, the first indication of the presence of this pest is the dying of the entire cane caused by the boring of the larva, as was the case in our experience narrated above, the infested canes should be promptly cut out and burned. These canes can be readily recognized by the dying of the leaves and by the small holes in them described above. They are most likely to be observed at the time of the blackberry harvest. It is of the utmost importance that the cutting and burning of these canes should be done promptly. For if it be delayed till autumn, the larvæ will have penetrated the roots and will then be beyond the reach of the pruning shears. As illustrating the practicability of this method of combatting this pest, I will state that, doubtless owing to the thoroughness with which we removed the infested canes from Dr. Caldwell's place, two years ago, not a single infested cane could be found last year or this.

THE SNOWY TREE-CRICKET.

Oecanthus niveus.

Order ORTHOPTERA ; family GRYLLIDÆ.

Numerous punctures arranged close together in a logitudinal series in the canes of raspberry and blackberry and each containing a long cylindrical egg.

MANY letters have been received at this office asking for information regarding injuries of a peculiar nature to the canes of raspberry. One writer, an extensive grower of raspberries, speaks of the attack as a sudden one, and says that the entire destruction of his plantation is threatened. Although we do not consider the matter so serious as indicated by this experience, the many inquiries regarding it show that the insect causing the injury is worthy a description in this place, notwithstanding it has been frequently described in entomological reports.

The attention of the fruit grower is usually first called to this injury by the death of the infested cane. It is observed that some canes fail to put forth any leaves in the spring. An examination of such canes reveals as the cause of their death the presence of a long ragged edged wound of the form indicated at *a* in Fig. 16. Frequently the cane will be split open at this place. If the rough surface of the wound be cut away with a knife, the injury will be found to consist of a longitudinal series of punctures placed close together. By splitting the cane the nature of the injury can be seen even better. Such a section is represented at *b* in the figure. The punctures extend through the woody part of the cane into the pith, and here there is in each an oblong, cylindrical egg. One of these eggs is represented enlarged at *c*.

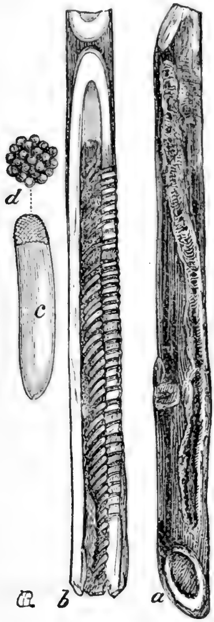

FIG. 16.—*Stem of raspberry with eggs of Oecanthus niveus; c, egg enlarged.*

The insect which thus seriously injures the raspberry canes in preparing a safe receptacle for its eggs is a delicate greenish-white cricket. On account of its color and of its habit of living among the foliage of trees and shrubs, it has received the popular name of The Snowy Tree-Cricket. Its technical appellation is *Oecanthus niveus*. Fig. 17 represents the male of this species. Its wing-covers are broad and transparent so that the folded wings can be seen through them. The wing-covers are crossed by oblique thickenings or ribs, which form a part of the musical apparatus of this insect. The female differs somewhat in appearance from the fact that the wing-covers are closely wrapped about the body, making the insect much narrower than her mate.

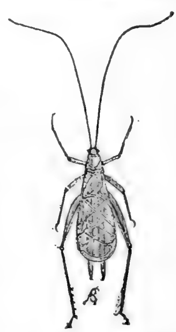
FIG. 17. — *Oecanthus niveus, male.*

The chirp of this cricket is a very familiar sound in most parts of our state during the latter part of summer and early autumn. It is a monotonous repetition of a cry, which with a little effort on the part of the listener, can be made to sound like *Katy-did*, *Katy-*

did. This cry is begun early in the evening and is contiuued unremittingly till late in the night; all of the males in one region chirping in unison. The chirp of this cricket is very different from that of the true Katy-did, being less rasping and much more monotonous. I have never heard the Katy-did at Ithaca; but I know it to be common in certain parts of this state. In those sections in this part of the country where the Katy-did does not occur, the chirp of the snowy tree-cricket is the most prominent of all sounds made in the night by insects.

Except for the injury caused by the female in ovipositing, the snowy tree-cricket is not regarded as a noxious insect. Its diet is said to consist in part at least of plant lice and other small insects. It is also said to feed later in the season on ripe fruits; but I have never heard of its being seriously injurious in this way.

This cricket lays its eggs in the canes late in the summer or in the autumn. But they do not hatch till the early part of the following summer. It is therefore a simple matter to cut out the infested canes in the spring after the other canes have put forth their leaves, but before the eggs have hatched, and by burning these canes to check the increase of the insect.

Although this insect oviposits by preference in the canes of black raspberry, its eggs are found in various other shrubs and even in the twigs of trees.

J. H. COMSTOCK.
M. V. SLINGERLAND.

CORNELL UNIVERSITY,

COLLEGE OF AGRICULTURE.

BULLETIN

OF THE

Agricultural Experiment Station.

BOTANICAL DIVISION.

XXIV.

DECEMBER, 1890.

The Clover Rust.

"That art on which a thousand millions of men are dependent for their sustenance, and two hundred millions of men expend their daily toil, must be the most important of all; the parent and precursor of all other arts. In every country, then, and at every period, the investigation of the principles on which the rational practice of this art is founded, ought to have commanded the principal attention of the greatest minds."—JAMES F. W. JOHNSTON.

PUBLISHED BY THE UNIVERSITY,
ITHACA, N. Y.,
1890.

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Agricultural Experiment Station.

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THE CLOVER RUST.

[*Uromyces Trifolii* (Alb. and Schw.) Wint.]

The Clover Rust should be distinguished from two other diseases of the Red and White Clovers of minor importance, one *Phyllachora Trifolii*, the other *Phacidium Trifolii*. Both of the latter produce black, smoothish discolorations, chiefly of the leaves; while the true "Clover Rust" infests the leaves, the leaf-stalk or petioles, and the stems. In appearance the spots of the Rust proper (Fig 1.) are oblong, well defined, brown in color, and somewhat powdery on the surface.

FIG. 1—*A Red Clover leaf affected with the Clover Rust* (*II and III Stages.*)

The disease has not been long known in America, but has prevailed to such an extent during the several wet, cool seasons preceding 1890, in many sections of the northern states, that it must be regarded as a disease likely to affect seriously, under conditions favorable to its development, an agricultural crop.

The natural relationships of *Uromyces Trifolii*, the fungus causing this disease, may be of interest to the farmer and gardener, as they are brought into close contact with a considerable number of fungus parasites differing widely in their character, habits, and natural affinities.

The above is one of the true "Rusts," all of which are included in the Natural Order *Uredineae*. To this also belongs the "Hollyhock Rust" or Blight. Many gardeners during the two years past have become alarmed concerning the spread of the latter on the cultivated Hollyhocks, where it appears as brown or gray wart-like

patches on the under surface of the leaves and on the petioles and stems. It comes to us from South America by the way of Europe, and its development is rapid and destructive.

Again the well-known "Wheat Rust" is another parasite belonging to the *Uredineae* and therefore not a distant relative of the Clover disease under consideration.*

OCCURRENCE, DISTRIBUTION AND INJURIOUSNESS.

Uromyces Trifolii has long been known in Europe on many species of Clovers and a few other Leguminosae, but has not attracted the attention of mycologists in America until recently. The form on our cultivated Clovers was no doubt introduced within a comparatively few years, but that on certain Rocky Mountain plants may be native.

The "Rust" proper was first reported in America in 1884, by Mr. Holway, in the "List of Iowa Uredineae" compiled by Mr. Arthur. The following table is probably sufficiently complete to show its present distribution in America, the host-plants, stages of fungus, and localities being given :

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*Perhaps not everyone knows that scientific men have proved experimentally what the New England colonists seem to have been convinced of nearly a century and a half ago, viz:, that the wheat-rust has several distinct stages, one of which does not grow at all on the wheat plant, but on the leaves of the barberry. The legislatures of the ancient colonies of Massachusetts and Connecticut, as early as 1755, passed stringent laws requiring the destruction of that shrub, because it had "been found by experience that the blasting of wheat and other English grain, is often occasioned by Barberry Bushes to the great loss and damage of the inhabitants."

The first stage of the Wheat Rust that on the Barberry, is bright, orange yellow and its spores are found inside the small membranous cups growing in clusters on the under surface of the leaf. This is usually called *stage I.* or the "*cluster-cup*" stage. Its spores germinate only on the wheat plant, the germ-tubes penetrating the interior of its stalks and leaves. The mycelium thus formed will soon send out its fruiting,—masses of yellow one-celled spores,—which appear on the plant surfaces, but not in cups as on the Barberry. This is *stage II* and is usually called the "*Red Rust*" of grain plants. After this appears on the same plants *stage III* of the fungus, apparent to the eye in brown or blackish vertical rows of spores, which are two-celled, the familiar "*Brown Rust*" of wheat. The connection and genetic succession of the above stages of the Wheat Rust fungus have been demonstrated many times over by mycologists.

In all *Uredineae*, or true "Rusts," where these three stages are present,

Host-Plant.	Stage.	Locality.
On *Trifolium repens* (White Clover) . .	I, II, III.	Conn. and New York
" " "	I, II, III.	Wisconsin
" " "	II, III.	Iowa
" " incarnatum	I, II, III.	Western States
" " pratense (Red Clover) . .	I, II, III.	New York
" " "	II, III.	Western States
" " hybridum (Alsike) . . .	II, III.	Conn. and New York
" " involucratum	III.	Utah
" " Parryi	III.	Colorado
" Glycyrrhiza lepidota	III.	Mont. and Nebraska

In 1888, in the *Botanical Gazette*, Prof. Underwood writes as follows: "*Uromyces Trifolii* appeared in the vicinity of Syracuse on *Trifolium pratense* (Red Clover), and is doing much damage. It is sometimes so abundant that the leaves are half or more dry and dead; and the damage is 5–20 per cent. on the value of the crop."

The uredo and teleutospore stages (the Rust proper) were also noticed near Ithaca in 1888, occurring in great abundance. During the year 1889, all three stages have been found on the Red

I, or the cluster-cup stage is also known as the *Aecidium stage* by botanists; II is known as the *Uredo stage*, and III as the *Teleutospore stage*.

The above reference to and explanation of a well-known fungus parasite is made for the purpose of assisting the general reader to better understand the significance of the following study of a parasite very similar to the Wheat Rust in habit and development. Reasoning from analogy, it had been supposed, (before this study was undertaken) that the brown "Clover Rust," consisting of two sorts of spores, (Figs. 6 and 7) corresponding to stages II and III (the Red and Brown Rusts) of the wheat fungus, were also genetically connected with a yellow cluster-cup stage, (Fig. 4) found sparingly on the clover plants. But it was a surmise only, the connection never having been, to our knowledge, experimentally demonstrated. To ascertain the truth of the above theory was one of the objects of this investigation. With that object in view as well as a determination of its mode of hibernating, its manner of attack on the host in the spring, and a settlement of any collateral questions which might arise, it was determined in the fall of 1889 to make the Clover Rust the subject of a careful study.

This work was planned by the undersigned and carried on in his laboratory; but the discoveries made and the conclusions reached, and in part stated herein, are the result of the faithful, careful work of the author, who as time permits will follow out the incompleted lines of investigation.

W. R. DUDLEY.

and the White Clover, the Rust stages so abundant as to destroy it is estimated, 50 per cent. of the second or "rowen" crop. During 1890 it was far less abundant. Although in the autumn it was plentiful, it did not injure the clover to a great extent.

In the scientific discussion of the parasite, which follows, we will consider, first the Vegetative characters, then the Reproductive organs, following with a description of our experiments.

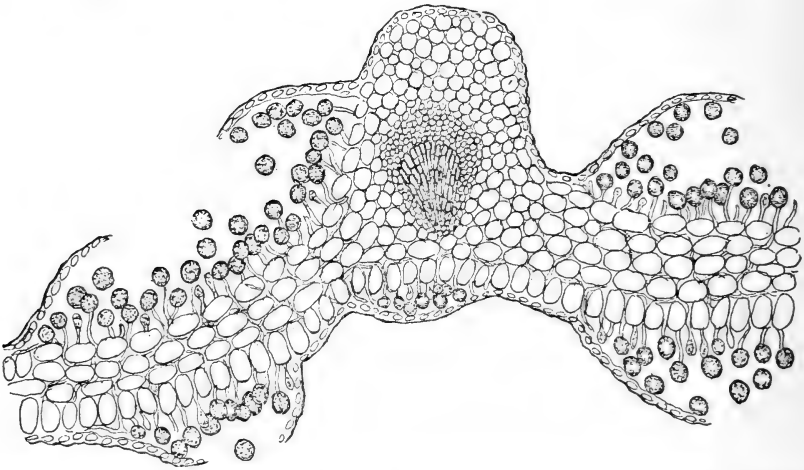

FIG. 2—*Transection of a Clover leaflet, showing the roundish leaf-cells, a group of vascular cells in the middle, belonging to the mid-vein, and the epidermis, raised and broken in places by the pressure of the Rust spores. The Rust spores (II stage), in sori or masses, are globose, granular and mostly attached to the mycelium, which cau be seen ramifying between the leaf-cells.*

THE MYCELIUM.

This is the vegetative portion living and growing inside the living clover leaves and stems, and which gives rise to the three spore forms described below. It has the same general characters in each, and consists of slender, colorless, much-branched threads (Fig. 2) which are more or less tortuous. These filaments, known as *hyphae*, obtain nourishment from the cells of the leaf of the host plant among which they ramify, but which they apparently never enter.

Repeated sections of the petioles of affected leaves were made but no traces of mycelium could be found in them. This seems to show that the mycelium is limited in extent and does not de-

scend the petioles to reappear in other leaves previously unaffected and there develop its spores ; also, that the spore forms which appear in the spring do not arise from mycelium which has lived over winter in the roots of the host.

REPRODUCTIVE ORGANS.

I. The Aecidium.—This form is not so abundant as the other two and does less injury. It is found upon the White Clover, of which it attacks the leaves and petioles, causing the latter to become swollen and distorted. (Fig. 3.) When it begins to develop, swollen and light-colored areas appear ; later, are produced the *aecidia* or "cluster cups" which appear to the naked eye as minute, orange-colored spots.

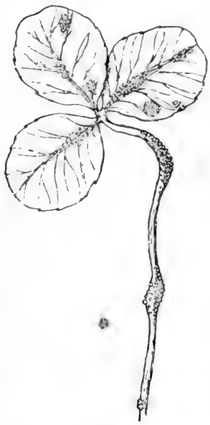

FIG. 3—*Leaf of White Clover with aecidia.*

Each aecidium (Fig. 4) is a colorless, cup-like body filled with chain-like rows of orange-colored spores (14 to 22 μ in diam.*), borne on the ends of erect hyphae which, as well as the cup itself arise from the mycelium within the leaf.

Among these "cluster cups," or developing before them, also more than once detected during the winter, were found smaller, nearly spherical bodies, the *spermogonia* which appear as minute brownish spots. Within each spermogonium are produced delicate, yeast-like bodies whose office is unknown.

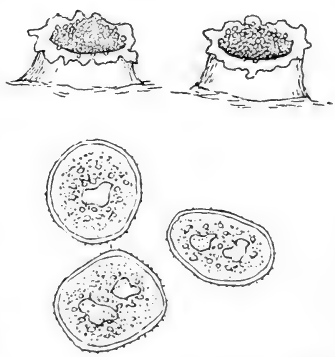

FIG. 4—*Two cluster cups or aecidia with contained spores* (× *about 50 diam.*) ; *also three acidiospores* (× *about 450 diam.*)

II. The Uredo Form.—This appears as circular or elongated, chestnut-brown spots or "sori." (Figs. 1, 2 and 5.) These are often so abundant as to almost entirely cover the surface of the leaf, causing it to wither and die. Each sorus consists of reddish-brown spores (14–21x21–25 μ) borne singly upon

* 1 $\mu = \frac{1}{1000}$ millimeter = nearly $\frac{1}{25000}$ of an inch.

the ends of erect hyphae arising from mycelium within the leaf and surrounded by the ruptured epidermis.

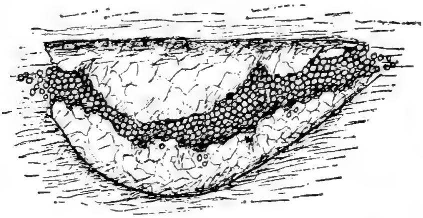

FIG. 5—*A uredo sorus, the epidermis raised, broken and showing the spores.*

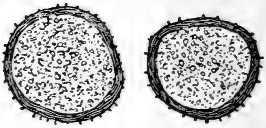

FIG. 6—*Uredo spores* (× *about 450 diameters.*)

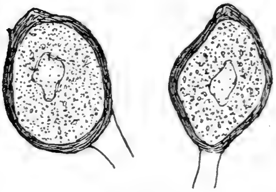

FIG. 7—*Teleutospores* (× *about 450 diameters.*)

III. The Teleutosporic Form.—This consists of dark-brown spores

($15–20x20–28\ \mu$)

borne in the same manner as the *uredo spores* and intermingled with them or forming sori by themselves. (See Fig. 7.) They undoubtedly arise from branches of the mycelium producing the uredo spores.

OBSERVATIONS ON THE DEVELOPMENT OF THE CLOVER RUST.

In October, '89, the Red Clover in the field was found to be affected with the uredo and teleutosporic forms, and the White Clover with all three forms. By December the uredo and teleutospores disappeared from the living plants and were found only upon the dead stems of the Red Clover. At various times during the winter,—which was a very open one,—White Clover plants were found whose petioles were affected with mycelium and spermagonia, but no aecidia. A Red Clover was also found with swollen areas upon its leaves. The plant being transferred to the conservatory, these developed aecidia. These discoveries seem to indicate a tendency at least, on the part of the aecidium stage to exist through the winter in the form of mycelium and spermagonia.

In November, Red and White Clover affected with the different spore forms were placed in the conservatory. The uredo and teleutospores soon disappeared from the red clovers and a crop of æcidia was developed. These in time, gave place on the same plants to uredo and teleutospores again, which, arising from sori

distinct from the aecidia, continued to be produced until summer.*

The three spore forms also disappeared from the White Clover; but later, aecidia were produced which continued to develop a few at a time, until summer, being accompanied during the latter part of the spring by uredo and teleutospores.

Though carefully watched during the spring, the plants in the field showed no traces of any of the spore forms until the middle of May when aecidia were discovered on the White Clover. A little later, the other two stages appeared upon the same plants but not until some time had elapsed were they found upon the Red Clover. All three forms continued to be produced, though not abundantly, throughout the summer.

From the above statements, the fact may be noticed that the uredo and teleutospores almost invariably followed the aecidia. This seemed to indicate that the aecidia gave rise to the other two forms but afforded no direct proof.

ARTIFICIAL CULTURES AND INFECTIONS.

Uredo Stage, II: Fresh, mature uredo spores germinated readily at all times during the year in distilled water or a decoction of clover leaves properly sterilized. Care was taken to sterilize all apparatus used in making the cultures.

A series of experiments showed that the uredo spores germinate most freely and rapidly at a temperature varying from 11—16° C.† Germination beginning in from 1½ to 3 hours. The lowest temperature limit of germination lay between 7° and 11° C; the highest, between 21° and 25°.‡

Artificial infections with germinating uredo spores were made upon small clover plants raised from seed sown in the fall. A portion of these seeds had been sterilized in copper sulphate solution to destroy any spores which might be attached to them. No traces of the fungus appeared upon the plants produced from either the sterilized or unsterilized seeds from which it may be inferred that the fungus was not propagated through the germi-

*So far as can be ascertained, the *aecidium* has never before been reported in this country upon the Red Clover, but there seemed to be no doubt that the form was identical with that on the White Clover.

†52°—61° Fahr.

‡7° Centigrade = about 45° Fahr.; 25° Cent. = 77° Fahr.

nating seeds of the host, supporting our belief expressed elsewhere that the disease is local and not general in the host plant.

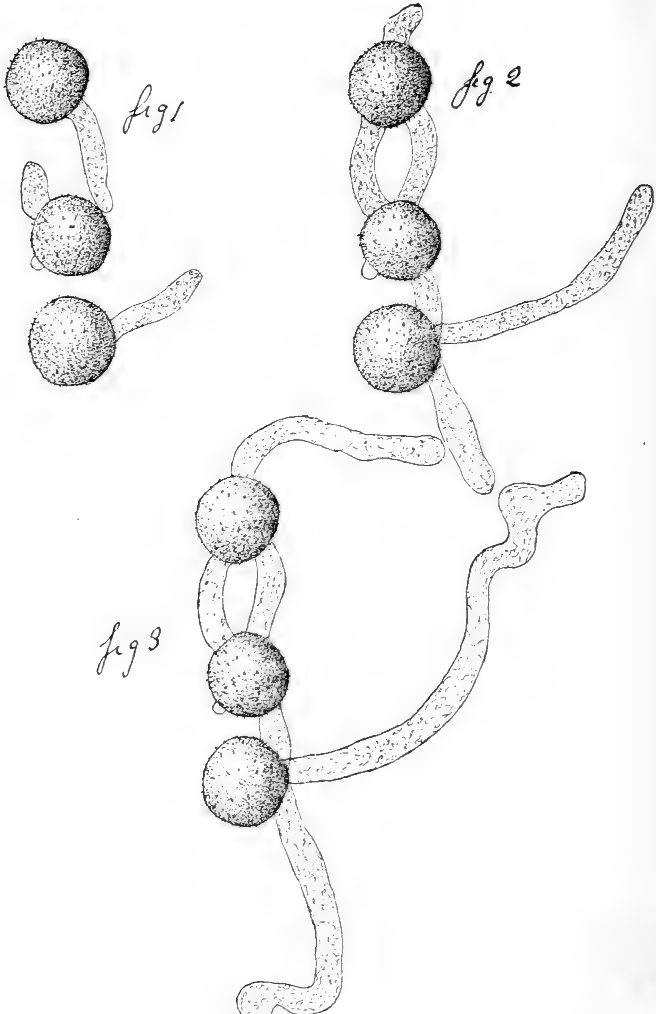

FIG. 8—*Uredospores germinating : sub-fig. 1 at 11 a. m. ; 2 at 12.30 p. m. ; 3 at 2 p. m.*

Eleven infections were made, nine of which were successful, uredo sori being produced in about two weeks, upon one or more of the infected leaflets in each case.

The two important facts learned from the above experiments are that the uredo spores prefer a low temperature in germination, and merely reproduce the uredo form.

The Teleutospore Stage, III: This is considered the resting stage in the *Uredineae*. It was therefore expected that those teleutospores which survived the winter on the dead clover stems would germinate freely in the spring. Repeated cultures were made in the winter and spring, but only seven spores in all germinated, and even in these cases the development was soon arrested. This result, so far as this species is concerned, would seem to strongly militate against the generally accepted theory that this is the hibernating stage; but before any conclusions can be reached, further investigations are necessary.

The Aecidium Stage, I:—The mature aecidio-spores germinated at all times during the winter and spring. Germination took place most rapidly at a temperature of 15°—18° Cent., often beginning in from one and one-half to three hours. 26° Cent., was the highest temperature limit of germination.

Infections with germinating æcidio-spores were made upon young clover plants selected from a large number of uninfected plants grown for the purpose. These experiments were regarded as of chief importance in this study; for should these infections result in the production of the uredo or teleutospores, the connection of the aecidium with the other two forms would of course be established. From infections with æcidio-spores made in the spring and early summer, uredo sori resulted on one Red and five White Clover plants, the sori appearing on one or more of the infected leaflets in each case and upon those leaflets only.*

*Upon one and two leaves respectively of two other Red Clovers, the sori appeared upon uninfected as well as infected *leaflets* but not on *leaves* uninfected This can be readily accounted for by the fact that the leaflets fold together at night and in this way, the fluid containing the spores could easily have been transfered to the leaflets previously uninfected.

One White Clover, while producing sori on infected leaflets, also showed them upon one uninfected leaf. As none of the control plants were affected, the most probable explanation of this error is that the leaf was accidentally infected.

From the preceding experiments the important fact was established, that the æcidiospores through their germination and subsequent mycelial development within the host, give rise to uredo spores; settling one of the principal questions involved in this study.

SUMMARY.

1. The parasitic Clover Rust is chiefly propagated throughout the growing season of the host, by the Uredo spores, owing to their abundance, rapid germination, and the fact that for the most part, they reproduce only their own form of spore.

2. The germination of the æcidiospores gives rise to uredo sori, thus demonstrating, what has heretofore been merely assumed, viz: the connection of the aecidium or "cluster-cup" of Clovers with the brown "Clover Rust."

3. Both uredospores and æcidiospores prefer a low temperature in germination. This accounts for the fact that during the middle period of the summer of 1890, which was very warm, little of the Rust appeared, while more of it was generated during the later and comparatively cooler months, although at no time did the amount equal that produced during the cool and moist midsummer and autumn of 1889.

The most important questions remaining to be investigated, in the life-history of the Clover Rust are its mode of hibernation, and the origin of the æcidia. The two questions are closely linked together, and two theories have occurred as possible solutions of them. First, the æcidia may be produced in the spring through the germination of teleutospores which live over winter on the dead clover stems. Second, the uredo and teleutospores may germinate in the fall, form mycelium in the *White Clover* plants, and survive the winter in them as mycelium and spermogonia. The first mode would seem the natural one for preserving the parasite through the winter; but the small number of germinations obtained from the teleutospores taken from the dead stems implies some other mode of hibernation. The second theory is supported by the fact that in 1890 at least, not only the æcidia, but mainly the uredo and teleutospores also, were found in spring and early summer, occurring mainly on the White Clover. The infection of the "rowen" or second crop of Red Clover evidently took place largely through the generations of uredospores derived from the

White Clover. Observations along these lines are still going on.

Suggestions.—So far as present observations go :

1. The early crop of Red Clover is not likely to suffer injury from the Rust.

2. As the second crop is likely to suffer greatly if the midsummer is cool, and as clover becomes a valuable fertilizer when plowed in, the fields should be carefully watched in such seasons and the crop might be plowed under to advantage.

3. Burning the clover fields in the fall would probably have some effect in checking the spread of the disease during the next season ; but the application of fungicides seems impracticable.

J. K. HOWELL.

CORNELL UNIVERSITY,

COLLEGE OF AGRICULTURE.

BULLETIN

OF THE

Agricultural Experiment Station.

ALL DIVISIONS.

XXV.

DECEMBER, 1890.

Sundry Investigations Made During the Year.

"That art on which a thousand millions of men are dependent for their sustenance, and two hundred millions of men expend their daily toil, must be the most important of all; the parent and precursor of all other arts. In every country, then, and at every period, the investigation of the principles on which the rational practice of this art is founded, ought to have commanded the principal attention of the greatest minds."—JAMES F. W. JOHNSTON.

PUBLISHED BY THE UNIVERSITY,
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Offices of the Director and Deputy Director, 20 Morrill Hall.

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CHEMICAL DIVISION.

I. MILK,

Since a large share of the chemical work of this station consists of the analysis of milk, a description of the methods used, and a tabulation of all of the results of the year is appropriate in this bulletin, even though many of these results have been published in other bulletins.

The topics considered are :

1. Description of methods.

2. Comparison of asbestos and paper methods.

3. Comparison of results by Dr. Babcock's centrifugal method for the determination of fat in milk, and the gravimetric method.

4. Tabulation of results on fat and solids in milk from cows on various rations.

5. Tabulation of results on cream raising by dilution, with additional data.

6. Tabulation of results on variations in fat of milk served to customers in dipping from cans.

7. Miscellaneous analyses.

1. METHODS OF ANALYSIS.

Dr. Babcock's gravimetric asbestos method is used in this laboratory ; instead of the test tubes, fodder tubes, as described by Prof. Caldwell in Bulletin XII of this station are used. For drying the milk, the same apparatus is made use of as described in that bulletin, except that air is used instead of hydrogen. The tubes are especially adapted to making a large nnmber of duplicate determinations of fat and solids. A reference to the cut and description, will at once show their particular fitness for this kind of work.

The best quality of asbestos is washed with dilute hydrochloric acid and distilled water, picked into long fibers and ignited.

On the perforated disk in the tube a layer of cotton about a centimeter in depth is placed, the asbestos is packed into the tubes, so as to form a column not so dense but that the ether can easily penetrate, and still compactly enough so as to absorb all of the milk in the upper two-thirds of the tube. The tubes are dried and weighed in the way mentioned in the bulletin referred to. From 6 to 8 c.c. of milk are weighed out with a weighing pipette, and allowed to drop slowly from the pipette on the asbestos; the tubes are dried again and weighed, the loss in weight being due to the amount of water in the sample. These tubes serve the purpose of glass-stoppered weighing tubes, as well as drying tubes. The fat is extracted in the ordinary way, and weighed.

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2. COMPARISON OF THE ASBESTOS AND PAPER METHODS.

The method as above described has been compared with Adams' paper method, and with the following results:

	Adams' paper method.		Babcocks' asbestos method.	
	Fats.	*Solids.*	*Fats.*	*Solids,*
1	3.88	13.37	3.96	13.39
2	4.24	13.24	4.27	13.16
3	3.73	12.91	3.77	12.80

The paper was prepared by treatment with dilute acetic acid, alcohol, and extraction twelve hours, using a return-flow condenser, with ether. With each determination of the fat a blank determination was carried through, and the amount of extract obtained from the paper ranged from .0079 grams to .0091 grams. The average of these amounts was subtracted from the several weights of fat obtained. Blank determinations carried on with the tubes filled with asbestos gave no extract.

Asbestos appears to be superior to paper. Corrections are always necessary on account of the ether-soluble matter in the paper coils; this is a variable quantity, and when a sample of milk has become acid, the paper will give up a much larger quantity of extract. With skim-milk or butter-milk this frequently amounts to a third or a half of the total weight of fat

obtained, and in case the skim-milk or buttermilk is acid, which so frequently occurs, the amount of paper extract will even equal or exceed the weight of fat present. The paper method cannot be used with satisfaction or safety on skim-milk or buttermilk, while the ignited asbestos can be.

3. COMPARISON OF RESULTS BY DR. S. M. BABCOCK'S CENTRIFUGAL METHOD FOR THE DETERMINATION OF FAT IN MILK AND THE GRAVIMETRIC METHOD.

Dr. Babcock's new method for the determination of fat in milk with the aid of a small centrifugal machine has been compared with the gravimetric method. The figures given in each column of the following Table are averages of duplicate determinations, and include results on the milk from individual cows, as well as from the mixed herd.

KIND OF SAMPLE.	Fats by gravimetric.	Fats by centrifugal.	NOTES.
Skim milk, ...	.60	.50	. . . .
Skim milk, ...	.47	.50	. . . .
Whole milk, ...	3.96	3.90	. . . .
Whole milk, ...	4.16	4.10	. . . .
Skim milk, ...	.51	.50	. . . .
Skim milk, ...	.72	.68	. . . .
Whole milk, ...	4.53	4.45	No hot water used in centrifugal
Whole milk, ...	4.27	4.23	" " " "
Watered milk, ...	2.00	2.00	" " " "
Watered milk, ...	2.31	2.50	Samples kept 24 hours after
Skim milk, ...	.68	.73	measuring before fats deter-
Skim milk, ...	1.54	1.50	mined.
Skim milk, ...	.49	.60	Samples kept 36 hours after
Skim milk, ...	.76	.73	measuring before fats deter-
Whole milk, ...	5.22	5.35	mined.
?	1.84	1.80	. . . .
?	1.28	1.30	. . . .

For the use of dairymen, this is the most rapid and accurate method which has yet been tested in this laboratory. The apparatus is not expensive; besides the centrifugal it consists simply of a number of test bottles, similar in shape to those used in Short's method, a measure for the milk, and one for the acid. Equal volumes of milk and concentrated sulphuric acid are mixed together in the test bottles, and then whirled in the centrifugal for five minutes, at the rate of nine hundred revolutions per minute.

The fat is raised to the neck of the test bottles with hot water, and after whirling for two minutes longer it is raised into the graduated tube, and then whirled another minute. The fat is read directly in per cent. on the graduated tube.

The apparatus is not patented, and can be obtained of Cornish, Curtis & Greene, Fort Atkinson, Wis. This station will give practical instruction to those who desire to become better acquainted with the workings of the method, in the same manner as indicated in Bulletin XVII of this Station.

ON THE EFFECT OF A GRAIN RATION FOR COWS AT PASTURE.

DATE.	Lot I. Pasture.		Lot II. Pasture and grain.		Lot III. Cut grass.		Lot IV. Cut grass and grain.	
	Fats.	Solids	Fats.	Solids	Fats.	Solids	Solids	Fats.
May 15	3.80	13.38	4.32	13.24	3.36	13.00	12.49	2.93
16	3.97	13.40	4.32	13.18	3.38	13.08	12.56	3.11
17	4.15	13.36	3.92	13.20	3.38	13.01	12.49	3 11
22	3.43	14.23	4.41	13.54	3.20	13.40	12.82	2.93
23	3.80	14.35	4.08	13.37	3.11	13.26	12.84	3.20
24	3.63	13.77	4.15	13.48	3.46	13.71	12.98	3.11
28	4.23	13.91	4.32	13.20	3.29	13.35	12.86	3.11
29	4.72	14.32	4.50	13.80	3.29	13.57	12.86	3.38
30	3.97	13.89	4.23	13.58	3.80	13.90	13.21	3.11
June 4	4.41	14.07	4.32	13.60	3.72	13.95	12.61	3.37
5	4.15	13.59	3.97	13.42	3.80	13.55	13.21	3.52
6	4.15	13.75	3.97	13.50	3.28	13.09	12.87	3.11
18	3.89	13.38	3.46	12.82	3.35	13.67	22.80	3.11
19	4.06	13.40	3.28	13.07	3.72	13.54	12.68	3.28
20	4.15	13.20	3.80	13.00	3.80	13.04	12.78	3.46
July 2	4.15	13.70	3.72	13.27	4.32	15.04	12.95	3.11
3	4.32	13.98	3.54	13.53	3.46	14.18	13.30	3.20
4	3.34	13.04	3.46	13.16	3.28	13.96	12.88	3.11
16	2.93	12.48	3.19	13.47				
17	3.28	13.15	3.37	13.28				
18	3.11	13.21	3.11	13.00				
30	3.19	13.54	3.11	12.88				
31	3.28	13.48	2.93	12.66				
Aug. 1	3.20	13.29	2.85	12.52				
12	3.54	13.13	3.19	12.96				
13	3.71	13.58	3.35	12.99				
14	3.35	13.03	3.80	13.40				
27	4.62	14.00	4.53	13.24				
28	4.10	13.45	4.61	13.37				
29	4.54	13.17	4.64	13.49				
Sep. 10	4.27	13.04	3.90	12.87				
11	4.39	13.48	4.76	14.20				
12	5.41	13.73	4.40	13.29				
24	5.70	15.27	4.74	13.74				
25	4.68	14.32	3.80	12.97				
26	4.84	14.49	4.23	14 41				

DATE.	One cow of lot I. Shadow.		One cow of lot II. Phantom.	
	Fats.	Solids.	Fats.	Solids.
May 17	3.46	12.62	3.46	12.50
24	3.20	13.23	3.55	13.69
June 6	3,11	13.26	3.28	13.36
20	3.72	13.12	3.46	13.36
July 18	3.11	13.38	3.02	13.45
Aug. 1	3.20	13.07	2.93	12.37
14	3.28	13.13	3.11	12.94
29	4.15	13.67	3.97	13.22
Lot	4.69	13.26	4.39	13.92
	4.61	13.52	3.93	13.04

CREAM RAISING BY DILUTION.

TABLE I.

			SET IN ICE WATER IN COOLEY CREAMER, TEMP. 44°.			SET IN COOLEY CAN IN AIR AND DILUTED WITH EQUAL WEIGHT OF COLD WATER.					
DATE AND TIME OF SETTING.	Temp. of milk . . .	Per ct. of fat in milk.	No. of hours set. . .	Weight of milk, lbs.	Per cent. of fat in skim milk.	Weight of milk, lbs.	Per cent. of fat in skim milk.	Temp. of water added.	Temp. after setting.	Temp. of room. . .	No. of hours set. . .
Sept. 10, 7.00 A.M.	90	3.62	22	18.	**.32**	18.50	**1.58**	47	68	60	22
" 10, 8 30 A.M.	*78	3.62	21	9.	**.20**	9.50	**1.08**	50	64	60	21
" 10, 5.30 P.M.	*84	4.31	23	32.	**.29**	19.	**1.22**	48	67	62	23
" 11, 5.35 P.M.	*84	4.39	23	16.	**.36**	18.75	**1.50**	58	70	62	23
" 11, 5.45 P.M.	*84	4.39	12	15.	**.17**	18.75		58	70	62	12
" 12, 7.00 A.M.	87	4.09	23	18.	**.21**	16.50	**1.24**	60	74	63	23
" 15, 8.00 A.M.	†101					36.	**1.26**	48	73	60	23
" 15, 6.00 P.M.	†100		12	37.75	**.21**	20.	**1.28**	56	76	66	23
" 16, 5.30 A.M.	91		11	18.50	**.1**	8.50	**1.04**	47	66	62	24
" 16, 8.00 A.M.	*83		22	13.3	**.29**	10.25	**1.04**	47	55	62	22
" 16, 6.00 P.M.	*86		12	17.2	**.2**	16.75	**1.34**	48	66	65	12
" 17, 5.30 A.M.	91		12	6.5	**.2**	15.	**1.46**	48	70	60	12
Average, 11 trials.					**.23**		**1.28**				

* Carried on route. † The milk in these two cases had been carried on the route, but was heated up to 100 degrees before setting.

TABLE II.

SET IN COOLEY CANS IN AIR AND IN RUNNING WATER, AND DILUTED WITH HOT WATER.

DATE.	Temp. of milk. . .	Per ct. of fat in milk.	Weight of milk, lbs.	Per cent. of water added.	Temp. of water added.	Temp. of milk after setting.	Temp. of air or running water in tank.	Per cent. of fat in skimmed milk.	
Aug. 20 . .	90	4.30	15	20	134	96	67	**1.78**	Set in air.
" 21 . .	92	4.15	15	20	132	98.5	72	**1.16**	
" 22 . .	92	4.06	15	20	132	100	62	**1.04**	
" 24 . .	91	4.65	15	20	136	98	63	**1.22**	Set in running water.
" 29 . .	90	5.05	12	50	130	104	64	**.84**	
" 31 . .	90	4.81	35	10	120	94	61	**1.10**	
" 31 . .	90	4.81	28	25	120	97	61	**1.10**	
Sept. 1 . .	*80	3.88	35	10	120	84	60	**1.03**	
" 1 . .	*80	3.88	14	25	120	90	60	**.79**	
" 11 . .	83		16	100	130	108	59	**1.04**	Set in air.
Average, ten trials, ...								**1.11**	

* Had been carried on milk route before setting.

TABLE III.

SET IN COOLEY CANS IN AIR AND RUNNING WATER, AND DILUTED WITH COLD WATER.

DATE.	Temp. of milk . . .	Per ct. of fat in milk.	Weight of milk, lbs.	Per cent. of water added.	Temperature of water added.	Temp. of milk after setting.	Temp. of room or water in tank.	Per cent. of fat in skim milk.
Aug. 20	90	4.30	8.5	20	54	83	67	**1.09**
" 21	92	4.15	15	20	54	87.5	72	**1.76**
" 22	92	4.06	15	20	54	86	62	**1.51**
" 24	91	4.65	30	20	54	84	60	**1.18**
" 24	91	4.65	15	20	54	84	63	**1.12**
" 29	90	5.05	12	50	52	76	64	**.78**
Average, six trials, ...								**1.24**

TABLE IV.

Set in Cooley Cans—No Water Added.					
Date.	Temp. of milk.	Per cent. of fat in milk.	Weight of milk, lbs.	Temp. of water in tank.	Per cent. of fat in skim milk.
Aug. 24	91	4.65	35.5	63	**.90**
" 31	90	4.81	28	60	**.87**
Average, ...					**.89**

TABLE V.

Setting in Shallow Pans.						
Date.	Temp. of milk.	Per cent. of fat in milk.	Weight of milk, lbs.	Temp. of air.	Temp. after setting.	Per cent. of fat in skim milk.
Aug. 31 .	90	4.81	12	64	90	.49
Sept. 14 .	92	4.31	106	62	92	.46
Aug. 31 .	90	4.81	12	64	94	.75

ADDITIONAL DATA IN REGARD TO CREAM RAISING BY DILUTION.

Diluted with 20 per cent. Hot Water.

Whole Milk.			*Skim Milk.*		
Solids.	Fats.	Solids not fat.	Solids.	Fats by difference.	Fats by deter.
13.44	4.30	9.14	10.92	1.78	1.78
13.44	4.65	8.79	10.05	1.26	1.22

Diluted with 20 per cent. Cold Water.

13.44	4.30	9.14	10.38	1.24	1.10
13.24	4.15	9.10	10.81	1.71	1.76

6.—VARIATIONS IN FAT OF MILK SERVED TO CUSTOMERS IN DIPPING FROM CANS.

From Bulletin XX.

FIRST TRIAL.

No. 1, . . 4.52		
" 2, . . 4.43	Taken from can A.	
" 3, . . 4;41		
" 4, . . 4.31		
" 5, . . 3.85	Taken from can B.	
" 6, . . 5.05		
" 7, . . 4.15		
" 8, . . 4.02	Taken from can C.	
" 9, . . 4.05		
" 10, . . 4.94		
" 11, . . 4.78	Taken from can D.	
" 12, . . 4.85		

SECOND TRIAL.

	a.	b.	Average.	
Sample 1, . . .	4.86	4.78	4;82	(Before starting.)
Sample 2, . . .	4.71		4.71	(Top of can.)
Sample 3, . . .	4.82		4.82	(One-third gone.)
Sample 4, . . .	4.83	4.74	4.78	(Two-thirds gone.)
Sample 5, . . .	4.73	4.83	4.77	(Bottom of can.)

THIRD TRIAL.

	a.	b.	Average.	
Sample 1, . . .	4.20	4.16	4.18	(Top of can.)
Sample 2, . . .	4.11	4.00	4.05	(One-fourth gone.)
Sample 3, . . .	4.13	4.01	4.07	(One-half gone.)
Sample 4, . . .	4.15	4.04	4.09	(Three-fourths gone.
Sample 5, . . .	4.01	4.00	4.00	(Bottom of can.)

7.—MISCELLANEOUS MILK ANALYSIS.

COMPOSITION OF WINTER MILK FROM HERD.

DATE.	Per cent. of fats.	Per cent. of total solids.	DATE.	Per cent. of fats.	Per cent. of total solids.
Dec. 5	3.91	13.14	Dec. 15	5.42	15.32
" 6	4.16	13.44	" 16	5.22	15.08
" 14	4.53	13.98	" 20	5 20	. . . .
" 14 . . .	4.27	13.25	" 20	5.60	. . . .
" 15	5.26	15.00	. . . .	. . . . .	. . . .

COMPOSITION OF SUMMER MILK FROM SAME HERD.

DATE.	Per cent. of fats.	Per cent. of total solids.	DATE.	Per cent. of fats.	Per cent. of total solids.
Aug. 21	4.30	13.45	Aug. 29	4.80	13.52
" 22	4.15	13.24	" 30	3.92	. . . .
" 27	4.65	13.44	. . . .	. . . .	. . . .

COMPOSITION OF MILK FROM COW HAVING UDDER INFLAMATION.

Fat	1.35	Undetermined	1.38
Ash	.92	Total solids	10.76
Albuminoids	5.79	Sp. gr.	1.018
Sugar	.32		

ANALYSIS OF CREAM—SAMPLE.

	I.	II.
Fats	20.31	23.80
Solids	26.14	28.11

In ten samples of cream in which the fats only were determined, the per centages ranged from 14.40 to 28.15.

II.—ANALYSES OF CATTLE FOODS.

(By W. P. CUTTER.)

NAME OF SAMPLE.	IN THE ORIGINAL SUBSTANCE.					
	Mois-ture.	Pure Ash.	Ether Ext'ct	Crude Prot'n	Crude Fibre.	N-free Ext'ct
Corn meal, ...	21.91	1.56	3.78	8.50	1.97	62.28
Corn meal, ...	17.87	1.35	4.01	9.10	2.13	65.54
Flesh meal, ...	8.98	15.06	15.78	53.12	. . .	. . .
Linseed meal, ...	12.21	5.31	4.84	30.62	11.33	35.69
Pearl barley feed, ...	8.26	4.02	3.47	11.13	3.03	70.09
Wheat bran, ...	13.43	5.40	2.83	14.25	7.37	56.77
	IN THE DRY SUBSTANCE.					
Ensilage, ...	69.00	6.67	3.82	9.97	24.92	. . .
Corn, ...	17.62	2.22	2.48	11.56	1.87	. . .
Corncob, ...	27.75	. . .	.10	1.87	28.12	. . .

This table does not include the samples of ensilage published in Bulletin XVI, a portion of this work having been done in the previous year.

NAME OF SAMPLE.	IN THE ORIGINAL SUBSTANCE.					
	Mois-ture.	Pure ash.	Ether extc't	Crude prot'n	Crude fibre.	N-free ext'ct
Beets—red, ...	86.02	1.50	.21	1.44	1.32	8.66
Clover hay alsike, ...	12.79	6.01	1.92	11.23	45.65	22.28
Clover hay alsike leavings, . . .	13.53	4.78	1.57	6.69	29.52	43.98
Corn meal, ...	8,74	2.98	8.99	10.45	4.56	54.51
Cotton seed meal,.	8.14	7.95	11.20	44.38	5.61	22.71
Hay, ...	8.45	5.45	2.82	8.56	23.89	59.28
Linseed meal, ...	9.18	5.43	9.90	41.18	7.20	39.29
Malt sprouts,.	12.70	6.06	1.65	25.76	9.25	44.54
Middlings, wheat, ...	9.12	.84	1.76	12.70	0.86	84.04
Red clover hay, ...	11.58	5.36	3.23	11.47	41.36	37.00
Red clover leavings, ...	11.00	4.44	3.70	8.24	38.28	34.40
Timothy hay, ...	9.37	5.00	2.55	5.93	36.26	40.89
Timothy hay leavings, ...	12.30	4.16	.75	4.16	39.96	38.04
Pea hulls, ...	11.41	3.35	1.93	6.50	45.38	33.43

III.—MISCELLANEOUS.

ASHES.

	Coal.	Water.	Potash.	Phos. Acid.
Canada ashes, ...	13.26	.56	3.33	1.55
Home ashes, ...	22.06	.31	1.92	1.03

	Water.	Nitrogen.	Potash.	Phos. Acid.
Tankage, dry, ...	6.27	12.00	——	1.10
Sea-grass and mud, ...	26.57	1.16	.67	.44

In order to obtain some idea of the draft made by a young apple tree on the soil, a tree two years old was prepared for analysis, and it yielded, on the dry substance, 0.891 per cent. of nitrogen, 0.122 per cent. of phosphoric acid, 0.44 per cent. of potash, and 60.83 per cent. of water.

The qualitative analysis of MILK and CREAM PRESERVALINE showed the presence of sodium, boric acid, and chlorine (in traces), and organic matter.

A SAMPLE OF BLOOD from a sheep that died suddenly at the University barn, fed on rations of oil meal, wheat bran, corn meal and turnip, ratio 1 to 4, gave on analysis (by W. P. Cutter).

Total solids, ...	17.94 per cent.
Albuminoids, ...	15.82 per cent.

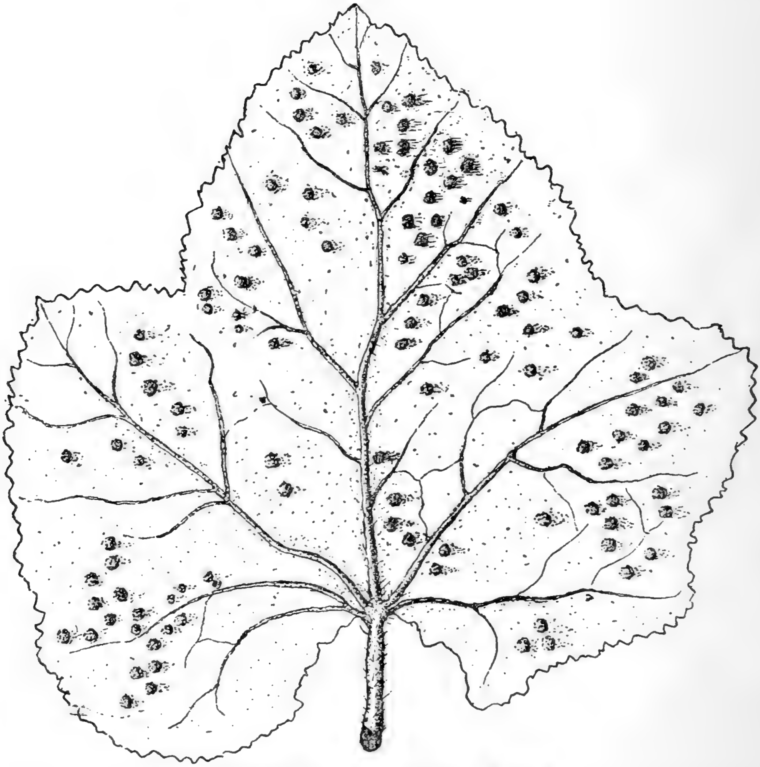
A number of consignments of evaporated apples from the western part of New York State to Germany, were rejected by the Custom House chemists of that government, on account of the presence of zinc. An analysis by W. P. Cutter of a similar sample showed in one kilogram of the apples 0.583 grams of zinc. The zinc came from the pans used in the process of evaporation.

The analytical work done in this laboratory is not only controlled by duplicate determinations, but in many cases with additional analyses of standard substances simultaneously carried on. In the case of nitrogen, with every eight determinations, one determination is made using a standard ammonium chloride. With phosphoric acid and potash the results are checked in like manner. The little time that is unoccupied with the work of the station is spent in the comparison of analytical methods, with their special bearing on agricultural chemistry.

HARRY SNYDER.

BOTANICAL DIVISION.

THE HOLLYHOCK RUST.



[*Puccinia Malvacearum, Mont.*]

Until 1886 the United States appears to have been free from this fatal visitant of the European hollyhock gardens. It appeared in eastern Massachusetts in that year, as recorded by Professor Farlow of Harvard, and was an undoubted immigrant from Europe by means of imported seed.

In 1889 it was sent me from Geneva, N. Y., by Dr. Emery, then of the New York Experiment Station, and in 1890 appeared abundantly in Ithaca. It has been sent in from other places in this state, but it has not apparently become prevalent in the Mississippi valley and westward.

Although it is not as yet a serious menace to gardeners in America, nevertheless they would do well not to neglect this warning of its approach, and ought, it seems to us, to make every

effort to bring it early under control, before the soil or neglected gardens become abundantly supplied with spores, and thereby sources of infection.

As a lesson for us, the experience of the old world may be very useful. The Hollyhock Rust in question appeared in Europe about 1869, spread over England and the continent in a few years, increasing to such an extent that the cultivation of the choice varieties of these beautiful flowers entirely ceased in many localities, thus entailing great losses, the magnitude of which, in the aggregate, was never fully known.

It affects the host-plant after this manner: In places where it has become established it appears in May and June on the leaves, stems and petioles of the host, having apparently wintered on the radical or root leaves. Externally it is seen in spots or *sori*, (see figure,) which are yellow at first. As seen on the under side of the leaf, they soon become wart-like and brown, or even gray, and consist wholly of two-celled spores. These sori, and the mycelium within the leaf from which the sori spring, may so increase as to cause the leaf to wither, dry up and appear as if scorched by fire, long before the time for the appearance of the flowers. Indeed, in many cases no flowers ever appear. Where the attack is not severe, these sori may remain and the leaves continue green until the latter fall in the autumn.

Several remedies for the disease were at last found effective by European growers, and that given in the *Gardener's Chronicle* for 1874, p. 243, is added below:

Permanganate of Potash, (*Sat. Sol.*),....*2 Tablespoonfuls.*
Water, ...*1 Quart.*

Apply to the spots and all diseased parts with a sponge, and not a syringe or sprayer. The remedy is cheap and easily obtained.

It has been thought that the disease cannot endure severe winters. The present promises to be unusually cold, and we shall watch its effect on the Rust. If the prevalence of the Rust in the spring demands it, a resumé of what is known concerning it will be published. Will each one interested, and acquainted with the disease send us a note of its severity in known localities, accompanied, if convenient, with a small specimen of a diseased leaf? Also, will each add the date of its first appearance in the places cited, as we shall be glad to know of its progress westward, and present geographical distribution in America.

WILLIAM R. DUDLEY.

AGRICULTURAL DIVISION.

THE EFFECT OF REMOVING THE TASSELS ON THE PROLIFICACY OF CORN.

It has been claimed that if the tassels were removed from corn before they have produced pollen, the strength thus saved to the plant would be turned to the ovaries and a larger amount of grain be produced. To test the effect of this theory the following trial was made during the past season.

In the general corn field a plot of forty-eight rows with forty-two hills in each row was selected for the experiment. From each alternate row the tassels were removed as soon as they appeared, and before any pollen had fallen. The remaining rows were left undisturbed.

The corn was Sibley's Pride of the North, planted the last week in May in hills, three feet six inches by three feet eight inches,, on dry, gravelly, moderately fertile soil.

On July 21, the earliest tassels began to make their appearance in the folds of the upper leaves and were removed as soon as they could be seen, and before they were fully developed. A slight pull was sufficient to break the stalk just below the tassel and the removal was easy and rapid.

On July 25, the plot was gone over again for the removal of such tassels as had appeared since the previous work, and at this time by far the greater number of the tassels were removed.

On July 28, when the plot was gone over the third time, the effects of the tasseling became apparent in the increased number of silks that were visible on the rows from which the tassels had been removed. On the 1008 tasseled hills there were visible 591 silks; on the 1008 untasseled hills, 393 silks.

On Aug. 4, the plot was gone over for the last time, but only a few tassels were found on the very latest stalks. The preponderance of visible silks on the tasseled rows was still manifest, there being at this time 3542 silks visible on the tasseled rows, and but 2044 on the untasseled rows.

The corn was allowed to stand without cutting until ripe.

On Sept. 29th to Oct. 1st, the rows were cut and husked, and the stalks and ears weighed and counted with the following results :

	Aggregate Yield.		Comp'r'ti'e Yield	
	Tassels left on.	Tassels removed	Tassels left on.	Tassels removed
No. of Good Ears,	**1551**	**2338**	**100**	**151**
No. of Poor Ears,	628	885	100	141
No. of Abortive Ears,	2566	951	100	37
Total No. of Ears,	4745	4174	100	88
Wt. of Merchantable Corn, lbs.	**710**	**1078**	**100**	**152**
Wt. of Poor Corn, lbs.	130	187	100	144
No. of Stalks,	4186	4228	100	101
100 Stalks weighed, lbs.	82	79	100	96

It will thus be seen that the number of good ears and the weight of merchantable corn, were both a little more than fifty per cent. greater on those rows from which the tassels were removed than upon those upon which the tassels were left. This is not only true of the two sets of rows as a whole, but with the individual rows as well. In no case did a row upon which the tassels were left produce anywhere near as much as the tasseled rows on either side of it, as is shown at length in the detailed table given below. In fact, the results given above are really the aggregate results of twenty-four distinct duplicate experiments, each of which alone showed the same thing as the aggregate of all.

By abortive ears is meant those "sets" that made only a bunch husks, and sometimes a small cob, but no grain. It will be noticed that they were by far the most numerous on those rows from which the tassels were not removed. It will also be noticed that the total of the good, poor, and abortive ears is about fourteen per cent greater on the rows on which the tassels were left, while the weight of merchantable corn is more than fifty per cent. greater on those rows from which the tassels were removed.

In the following table are given the details for each row. The rows contained forty-two hills, and ran north and south. Row No. 1 was on the west side. The whole plot suffered severely by the drought; but the west side less so than the east, consequently as the rows proceed from west to east the yield particularly of good corn grows less and less, but it will be seen that the relation between the yield of the rows on which the tassels were left, and the rows from which they were taken off, remains about the same.

	Number of Ears.			Wt. of Corn Lbs.		Stalks.	
	Good.	Poor.	Abortive.	Good.	Poor.	Number.	Wt. Lbs.
Row 1. Tassels removed	**123**	**30**	**28**	**60**	**4**	**171**	**144**
" 2. " left on .	94	28	94	46	4	176	142
" 3. " removed	**135**	**19**	**36**	**64**	**4**	**181**	**155**
" 4. " left on .	82	31	71	41	4	173	153
" 5. " removed	**128**	**27**	**19**	**58**	**4**	**176**	**139**
" 6. " left on .	87	22	86	39	4	166	140
" 7. " removed	**110**	**32**	**27**	**52**	**7**	**186**	**153**
" 8. " left on .	84	20	84	39	5	182	152
" 9. " removed	**116**	**25**	**41**	**56**	**4**	**174**	**152**
" 10. " left on .	83	22	78	43	4	177	122
" 11. " removed	**126**	**21**	**32**	**55**	**5**	**187**	**142**
" 12. " left on .	103	15	97	43	3	176	145
" 13. " removed	**120**	**29**	**45**	**60**	**6**	**189**	**158**
" 14. " left on .	94	26	77	45	7	185	153
" 15. " removed	**114**	**20**	**34**	**60**	**4**	**176**	**150**
" 16. " left on .	73	32	121	34	6	181	163
" 17. " removed	**114**	**20**	**33**	**58**	**4**	**162**	**145**
" 18. " left on .	78	29	68	37	5	173	156
" 19. " removed	**111**	**28**	**29**	**54**	**6**	**167**	**136**
" 20. " left on .	79	18	72	37	3	180	139
" 21. " removed	**103**	**27**	**43**	**49**	**3**	**181**	**149**
" 22. " left on .	77	22	104	33	4	185	148
" 23. " removed	**107**	**32**	**27**	**48**	**6**	**175**	**129**
" 24. " left on .	67	31	100	31	5	176	123
" 25. " removed	**102**	**29**	**48**	**46**	**7**	**173**	**130**
" 26. " left on .	62	25	126	32	5	176	144
" 27. " removed	**98**	**39**	**32**	**47**	**9**	**177**	**122**
" 28. " left on .	52	31	112	25	8	171	156
" 29. " removed	**95**	**45**	**36**	**45**	**9**	**172**	**129**
" 30. " left on .	43	38	108	22	9	166	125
" 31. " removed	**91**	**41**	**44**	**42**	**8**	**185**	**131**
" 32. " left on .	61	25	110	26	6	176	137
" 33. " removed	**84**	**43**	**41**	**37**	**17**	**181**	**129**
" 34. " left on .	41	35	124	19	9	169	133
" 35. " removed	**74**	**50**	**49**	**33**	**11**	**168**	**137**
" 36. " left on .	52	22	134	23	5	172	139
" 37. " removed	**75**	**48**	**60**	**29**	**11**	**185**	**139**
" 38. " left on .	33	25	151	13	6	187	145
" 39. " removed	**60**	**41**	**57**	**24**	**9**	**159**	**137**
" 40. " left on	45	18	133	16	4	185	141
" 41. " removed	**71**	**56**	**58**	**26**	**8**	**180**	**145**
" 42. " left on .	42	29	95	17	6	161	143
" 43. " removed	**70**	**56**	**32**	**30**	**12**	**174**	**126**
" 44. " left on .	39	32	143	16	6	175	145
" 45. " removed	**51**	**78**	**50**	**23**	**18**	**174**	**132**
" 46. " left on .	29	25	168	13	6	154	152
" 47. " removed	**60**	**49**	**50**	**22**	**11**	**175**	**125**
" 48. " left on .	46	27	110	20	6	164	142

While for a single trial the results of this experiment seem particularly marked and conclusive, it yet remains to be determined whether it will pay for a farmer to remove any considerable proportion of the tassels from his corn, what proportion it will be best to remove, (for some evidently must be left), and whether all that it is advisable to remove may be taken off at one time or not. So far as we could estimate the time taken, it certainly paid us from a commercial standpoint to remove all the tassels from one-half the rows this year. It is also still to be determined whether the removal of the tassels would be followed with the same effect in a season and on a soil where there was abundant moisture for all the needs of the plant at the time when the tassels were shooting and the ears forming.

SUGAR BEETS.

Seed of five varieties of sugar beets was received from the Department of Agriculture, and was planted April 25th on a warm, fertile, gravelly loam. The beets grew well but suffered severely from a drought in the latter part of July.

Seed from the same source was also sent to seven correspondents in different parts of the state, but only four returned samples of beets, and of these two were unfortunately lost or destroyed in the confusion of moving the laboratory from one building to another.

Below is given the percentage of sugar as determined by Harry Snyder, Assistant in Chemistry.

VARIETY.	Yield per acre. Lbs.	Total dry matter. Per ct.	Total sugar. Per ct.
Simon LeGrand's White Improved	40450	15.75	9.91
Bulteau Desprez Richest	70950	18.52	11.64
Florimond Desprez Richest	44800	16.80	10.60
Dippe's Vilmorin (sample lost)	34230	. . . .	. . . .
Dippe's Kleinwanzleben	40450	16.48	10.34
" " Aurelius, Cayuga Co.	23335	14.47	9.00
" " Groton, Tomp. Co. .	36950	13.17	7.93
" " Slaterville, Tomp. Co.	34850	. . . .	. . . .
" " Clyde, Wayne Co. . .	26395	. . . .	. . . .

The most striking feature of the table is that the crops producing the greatest yield per acre gave beets containing the largest percentage of sugar. The yields in all cases are computed from small areas, and the smaller yields reported from Cayuga and Wayne counties are undoubtedly due to the wet weather at seeding time and again just before harvest, from which Tompkins county in a measure escaped.

The thanks of the Station are due Messrs. A. D. Baker, of Aurelius, Cayuga county ; W. H. Burnham, of Groton, Tompkins county ; R. G. H. Speed, of Slaterville, Tompkins county ; and George C. Watson, of Clyde, Wayne county, for their trouble in planting the seed and in sending samples to the Station for analysis.

Below is given the average percentage of sugar in beets grown in different parts of the country. It contains all the analyses that were found in a somewhat rapid examination of the bulletins and reports of the various Agricultural Experiment Stations. It will be seen that the beets of our own state compare somewhat unfavorably with the others ; but the matter would seem to be worthy of further study, as the past season was, on the whole, an unfavorable one for sugar beets in this state.

	No. of Analyses.	Total Sugar per cent.
California,	5	10.70
Canada,	36	13.91
Colorado,	32	10.22
South Dakota,	17	9.14
Indiana,	10	11.93
Nebraska,	9	12.66
New York,	6	9.90

Most of these analyses were made in 1888 and 1889, from the crop of those years.

SUGAR BEETS AS STOCK FOOD.

As the sugar beet is often recommended to be grown for stock, it seemed worth while to make a somewhat careful study of their merits for this purpose as compared with mangels. The sugar beets were grown in alternate rows with mangels, in the ordinary "beet patch," so that they received the same care, cul-

tivation, and fertilizing, that we ordinarily give our mangel crop. At the time of harvest three of the intervening rows of mangels, as well as the sugar beets, were weighed with the following results:

	Lbs. per acre.
Row 1, Mangel, Long Red,	60370
" 2, Sugar beet, Simon Le Grand's White Improved,	40450
" 3, Mangel, Long Red,	66590
" 4, Sugar beet, Bulteau Desprez Richest,	70950
" 5, Sugar beet, Dippe's Kleinwanzleben,	40450
" 6, Sugar beet, Florimond Desprez Richest,	44800
" 7, Mangel, Long Red,	61600
" 8, Sugar beet, Dippe's Vilmorin,	34230

Taking the average of the different varieties of sugar beet, and of the three rows of mangels, and reducing the whole to tons per acre, as an easier means of comparison, we have:

5 varieties of Sugar beet averaged	23.1 tons per acre.
3 rows Long Red Mangel averaged	31.4 tons per acre.

A difference of 36 per cent. in favor of the mangels, though one variety of the sugar beet yielded considerably more than the mangels. Moreover it is fully twice the labor to harvest the sugar beets, so that it would seem clear that, if roots are to be raised for stock, so far as yield per acre is concerned, mangels are much to be preferred to sugar beets.

Below is shown the average percentage composition in food constituents of two analyses each of mangels and sugar beets:

	Sugar Beets.	Mangels.
Water,	86.18	90.32
Ash,	.78	.72
Crude Protein,	1.12	1.10
Ether Extract (fat),	.10	.12
Crude fiber,	.95	.67
Nitrogen-free Extract (Carbhydrates),	10.87	7.07
	100.00	100.00
Nutritive ratio as 1 is to	10.8	7.3

It will be seen that the main difference in the two is in the less amount of water and greater amount of nitrogen-free extract (sugar) in the sugar beets. Since beets are usually fed in connection with other foods in such quantities that they do not materially affect the nutritive ratio of the whole ration, we may throw this difference aside and consider only the difference in dry mat-

ter as affecting the value of the beets for food. The difference above of a little more than four per cent. in the amount of dry matter would affect the whole crop something like this :

23.1 tons sugar beets, containing 13.82 per cent. dry matter, will give a yield of 3.19 tons dry matter per acre.

31.4 tons mangels, containing 9.68 per cent. dry matter, will give a yield of 3.04 tons dry matter per acre.

So that as between sugar beets and mangels, as raised by us this year, the yield of dry matter per acre is just about equal, and the difficulty in starting and in harvesting the sugar beets becomes the main difference in raising the two crops.

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*THE EFFECT ON FOWLS OF NITROGENOUS AND CARBONACEOUS RATIONS.

On July 2, 1889, ten Plymouth Rock hens, one year old, and as nearly as possible of uniform size, were selected from a flock of thirty-five. At the same time ten chickens, hatched from the same hens mated with a Plymouth Rock cock, were similarly chosen. The chickens were about six weeks old, healthy and vigorous and of nearly the same size. Up to the time of purchase both hens and chickens had full run of the farm. The hens foraged for themselves and were given no food ; the chickens had been fed corn meal dough, sour milk and table scraps.

A preliminary feeding trial was continued for twenty-five days, during which time both hens and chickens were confined, all together, in a fairly well lighted and ventilated room, and fed a great variety of food in order that all should go into the feeding trial as nearly as possible in the same condition. During this preliminary feeding both hens and chickens increased in live weight. The ten hens from a total of 44 lbs. 12 oz., to 47 lbs., 1.5 oz., or 3.75 oz. each, and laid 93 eggs. The chickens, from a total of 9 lbs. 15 oz., to 18 lbs., or 12.9 oz., each.

* This article is condensed by permission from a thesis prepared for the degree of Bachelor of Science in Agriculture, by James Edward Rice, a graduate of the class of 1890. The work was planned and wholly carried out in the most careful manner, by Mr. Rice, under the immediate supervision of the Director. The results have been thought worthy of publication in the Station Bulletin.

Food, shells and water were kept constantly before the fowls. Basins which contained the food and water were kept within a a box constructed of lath, so arranged that the fowls could reach between the slats and procure food and drink without wasting or soiling.

July 26th the hens and chickens were each separated into two lots of five each, as follows:

Hens, nitrogenous ration, weighed 23 lbs. 8.5 oz.

Hens, carbonaceous ration, weighed 23 lbs. 9 oz.

Chickens, nitrogenous ration, weighed 8 lbs. 15 oz.

Chickens, carbonaceous ration, weighed 9 lbs. 1 oz.

The four lots were placed in separate pens where they remained during the entire experiment, which lasted 125 days. They were fed and watered once daily, and an account kept of the food eaten and water drank. At each feeding the food and water remaining was weighed back and deducted from the amount charged at the previous feeding.

The hens and chickens fed a nitrogenous ration, were given daily all they would eat of the following mixture: ⅓ part wheat bran, ⅓ part wheat shorts, ⅓ part cotton seed meal, 2 parts skimmed milk, and will be designated Lot I.

The hens and chickens fed a carbonaceous ration, were given daily all they would eat of a ration of cracked maize and maize dough, and will be designated Lot II.

Both groups were given a small amount of green clover as long as it lasted, and afterward cabbage.

For convenience the experiment was divided into five periods of twenty-five days.

FOOD CONSUMED AND INCREASE IN LIVE WEIGHT.

During the first period all the fowls seemed in good health except the carbonaceous fed chickens, they, during this as in all succeeding periods, were restless and peevish, always moping or hunting for something to eat, though their trough was filled. When fed they would greedily take a few mouthfuls and then, with their hunger still unappeased, would leave the dish. They always ate ravenously the green food which was given them, as did the hens and chickens of Lot I. The hens of Lot II, on the contrary, seemed quite willing to squat about the pen and subsist on the maize diet, and strangely enough, cared little for green

food. The clear maize diet was accompanied by such ill effects, that the chickens of each lot, after the first period, were given daily each one-fourth ounce of wheat, and the hens each one ounce. The wheat was increased during the fourth and fifth periods in the case of the chickens to one ounce each. During the second period, one of the chickens fed nitrogenous food, and during the third period another of the same lot were taken ill and removed from the experiment. Both seemed to be suffering from impacted crops, as the stomach and gizzard in each case were found to be empty.

The fact that the sick chickens disliked the nitrogenous ration, and that since the first period the amount of food eaten by the hens and chickens of Lot I had continually decreased, led to the belief that their food might be too nitrogenous, and as during the last days of the third period one of the hens in Lot I was also ill, it was decided to discontinue the use of cotton seed meal and to use linseed meal instead. The hen recovered soon after the change in food.

The supply of skim milk running short in the last two periods, water was used instead in mixing the ration of the lots fed nitrogenous food.

At the beginning of the fifth period one-half of the linseed meal in the ration of Lot I was removed, and cotton seed meal substituted. This combination seemed a happy one, for on this ration both hens and chickens made large gains.

At the end of the experiment little difference could be seen in the hens of the two groups; but the two lots of chickens were in striking contrast. While the chickens fed on nitrogenous food were large, plump, healthy, active, and well feathered, the chickens fed on a carbonaceous ration were in general much smaller, sickly, and in several cases almost destitute of feathers. Two of them had perfectly bare backs and so ravenous were they for flesh and blood that they began eating one another.

The inability of the chickens fed on a carbonaceous diet to throw out new feathers and the ability of the chickens fed on a nitrogenous diet to grow an enormous coat of feathers, is a splendid illustration of the effect of the composition of the food in supplying certain requirements of animal growth. It was plain to see that maize, even when assisted by a small amount of wheat and green clover, could not supply sufficient nitrogen for the growth of feathers.

TOTAL FOOD CONSUMED DURING EXPERIMENT.

Lot I—Nitrogenous.	Hens. lbs	*Chicks. lbs-	Lot II—Carbonaceous.	Hens. lbs.	Chicks. lbs.
Bran	29.90	21.85	Maize	82.15	51.30
Shorts	29.90	21.85	Green clover	18.75	18.75
Cotton seed meal	21.48	13.24	Cabbage	16.00	16.00
Linseed meal	8.43	8.61	Wheat	15.63	11.71
Skimmed milk	105.49	61.33			
Wheat	15.63	11.71			
Green clover	18.75	18.75			
Cabbage	16.00	16.00			
Total	245.58	173.34	Total	132.53	92.76
Nutritive ratio	1 : 3.1	1 : 3	Nutritive ratio	1 : 7.8	1 : 8

*Calculated for five chicks, based upon the amount eaten by the three after the two sick were removed.

EGGS LAID AND GAIN IN WEIGHT—HENS.

	Lot I. Nitrogenous.	Lot II. Carbonaceous.
Live weight, July 26th	23.53	23.56
Live weight, November 27th	21.31	22.00
Loss	2.22	1.56
Number of eggs laid	79	26
Weight of eggs laid, lbs.	8.25	2.92
Average weight of eggs, ozs.	1.67	1.80
Gain in weight, including eggs, lbs.	6.03	1.36

GAIN IN LIVE WEIGHT—CHICKENS.

	Lot I. Nitrogenous.	Lot II. Carbonaceous.
Live weight, July 26th	8.94	9.06
Live weight, November 27th	17.89	12.63
Gain, pounds	8.95	3.57
Gain, per cent.	100.11	39.40

It will thus be seen that while both lots of hens lost weight during the experiment, the loss was slightly greater with those fed nitrogenous food, but these produced by far the most eggs.

The chickens fed on nitrogenous food just about doubled in weight, while those fed carbonaceous food only added about one third to their weight.

PRODUCTION OF EGGS.

During the first week the carbonaceous fed hens laid three eggs while the others laid two. The two groups were therefore practically evenly divided at the start as to the condition of the laying stage. At the end of the first period the nitrogenous fed hens had laid forty-three eggs and the carbonaceous fed hens had laid twenty. During the next twenty-five days the former laid thirty and the latter six; during the third period the former laid six and the latter not any. From this time on no eggs were received from either group. The decline in egg production was probably due in large part to the fact that the hens began to moult during the second period and continued to do so during the rest of the experiment.

The eggs laid by the nitrogenous fed hens were of small size having a disagreeable flavor and smell, watery albumen, an especially small, dark colored yolk, with a tender vitelline membrane which turned black after being kept several weeks. While the eggs of the carbonaceous fed hens were large, of fine flavor, of natural smell, large normal albumen, an especially large rich yellow yolk, with strong vitelline membrane which was perfectly preserved after being kept for weeks in the same brine with the other eggs,

Samples of the eggs from each lot of fowls were privately marked and sold to a boarding house where the cook did uot know that the eggs were undergoing a test. On meeting the cook several days later the following words were heard: "Do you expect me to cook such eggs as these! About every other one is spoiled."

On examination of the ovaries after slaughtering, it was found that in the case of one of the carbanaceous fed hens the ovules were in a more advanced stage, but on the whole the nitrogenous fed hens were much nearer the laying period. With this single exception, the cluster of ovules in the carbonaceous fed hens were uniformly small. Neither group would have laid under any probability for several weeks. It would seem from these facts, together with the fact that during the experiment the nitrogenous fed hens laid more than three times as many eggs, that a nitrogenous ration stimulates egg production.

THE RESULTS OF SLAUGHTERING.

On November 27th the fowls were slaughtered. Each fowl was weighed, wrapped in a bag to prevent floundering, and killed by severing an artery in the roof of the mouth. The blood was caught in a glass jar. The fowls were then picked and the feathers weighed, after which the body was laid open longitudinally by cutting alongside the sternum and through the back bone. When all had been thus prepared they were hung up in groups to be photographed, but the photographs were quite unsatisfactory so far as showing the relative proportions of fat and lean. The accompanying drawing made from the photograph shows the relative development of an average pair of chickens. Attention is particularly called to the thighs.

One half of each fowl was tested by cooking for flavor, succulence and tenderness. The other half was carefully prepared for chemical analysis by separating the meat from the bones. The flesh was thoroughly mixed and run through a sausage cutter, mixed again, and the process repeated three times. From different parts of this mixture a large sample was taken, from which the chemist took his samples for analysis. The right tibia of each fowl was tested for strength by placing it across two parallel bars and suspending a wire on its center, on which were placed small weights until the bone gave way.

DRESSED WEIGHT, INTERNAL ORGANS, ETC.

	HENS.		CHICKENS.	
	Lot I. Nitrogenous.	Lot II. Carbonaceous.	Lot I. Nitrogenous.	Lot II. Carbonaceous.
Live weight, lbs	21.31	22.	17.89	12.63
Dressed weight. lbs . .	14.86	15.09	12.01	8.89
Dressed wt., per ct. lbs .	69.7	68.6	67.1	70.5
Weight of blood, lbs . .	.75	.66	.55	.34
Weight of feathers, lbs .	1.41	1.25	1.28	.66
Wt. of intestinal fat, lbs	.59	1.98	.34	.66
Weight of offal, lbs . . .	3.70	3.02	3.62	2.08
Weight of bones, lbs . .	3.47	3.63	3.18	2.69
Weight of flesh, lbs. . .	11.39	11.47	8.93	6.20

The breaking strain of the right tibia was as follows for the hens and chickens of the various lots :

Average, hens, nitrogenous, ... 48.16
Average, hens, carbonaceous, ... 51.74
Average, chickens, nitrogenous, ... 46.64
Average, chickens, carbonaceous, ... 31.18

There was little difference in the strength of the bones of the hens, undoubtedly because the bones were mature before the feed-

ing began, and were little affected by the feeding. We find, however, that the bones of the chickens fed on nitrogenous food were almost fifty per cent. (49.6) stronger than those fed carbonaceous food.

The difference in the composition of the flesh, as shown by the analysis of Mr. W. P. Cutter, is given below :

	Hens.		Chickens.	
	Lot I. Nitrogenous.	Lot II. Carbonaceous.	Lot. I. Nitrogenous.	Lot II. Carbonaceous.
Albumenoids .	43.81	25.13	52.00	30.06
Fat	12.59	20.76	5.54	11.34

The flesh of each group was submitted to a number of persons for a cooking test, and the almost unanimous verdict was that the flesh of the fowls fed a nitrogenous ration was darker colored, more succulent, more tender, and better flavored, though on this last there was some difference of opinion.

CONCLUSIONS.

So far as it is warrantable to draw any conclusions from a single experiment of this kind, it would seem that :

Chickens fed on an exclusive corn diet will not make a satisfactory development, particularly of feathers.

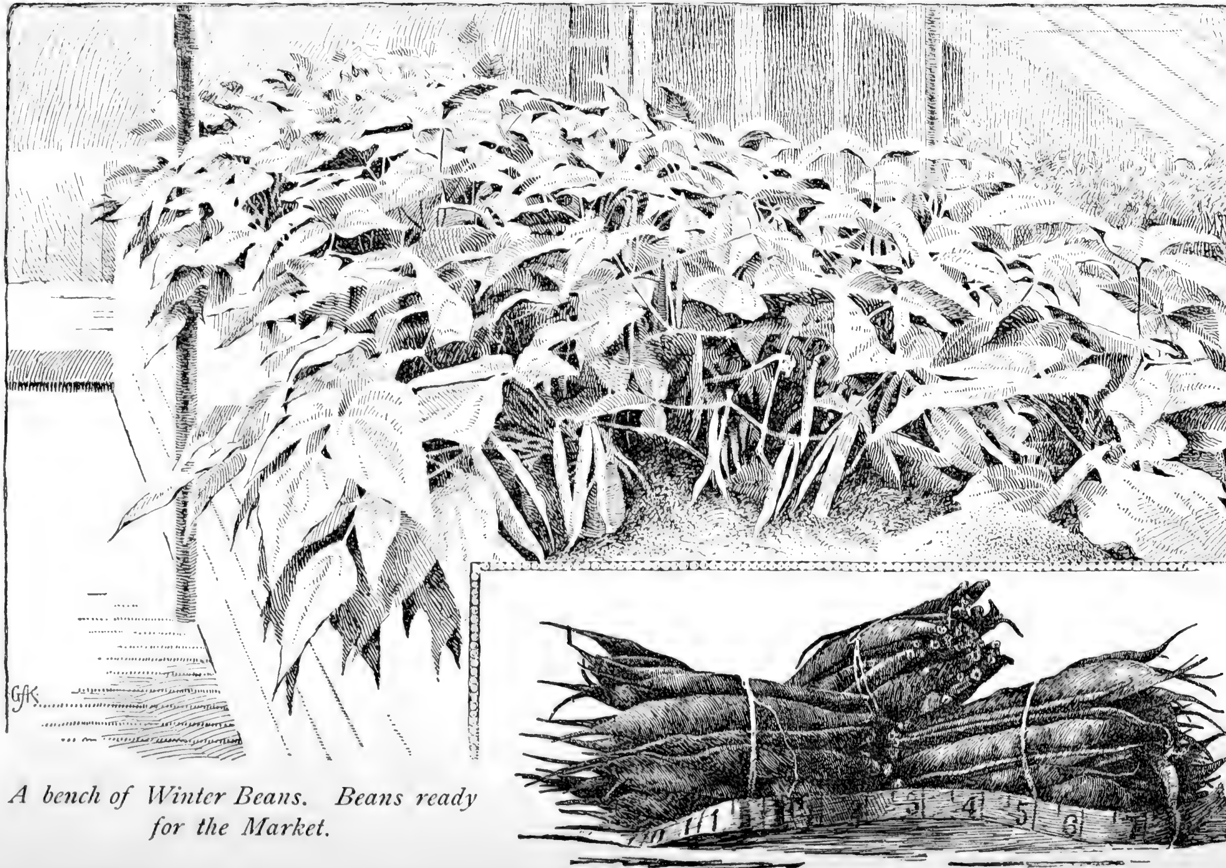
The bones of chickens fed upon a nitrogenous ration are fifty per cent. stronger than those fed upon a carbonaceous ration.

Hens fed on a nitrogenous ration lay many more eggs but of smaller size and poorer quality than those fed exclusively on corn.

Hens fed on corn, while not suffering in general health, become sluggish, deposit large masses of fat on the internal organs, and lay a few eggs of large size and excellent quality.

The flesh of nitrogenous fed fowls contains more albumenoids and less fat than those fed on a carbonaceous ration, and is darker colored, juicier and tenderer.

I. P. ROBERTS.



A bench of Winter Beans. Beans ready for the Market.

HORTICULTURAL DIVISION.

THE FORCING OF BEANS.

Bush beans are easily forced, and they constitute one of the best secondary winter crops. We ordinarily grow them upon cucumber, melon, or other benches while waiting for the cucumbers or melons to attain sufficient size in the pots for transplanting. Beans will be ready for picking in six or eight weeks after sowing, in midwinter. Their demands are simple, yet exacting. They must have a rich moist soil, strong bottom heat, and the more light the better. We cover our benches with eight or ten inches of soil, the lower third of which is a layer of old sods. The top soil we make by adding about one part of well rotted manure to two parts of rich garden loam. The soil must never be allowed to become dry, and especial care must be taken to apply enough water to keep the bottom of the soil moist, and yet not enough to make the surface muddy. With the strong bottom heat which we use for beans, the soil is apt to become dry beneath.

Our benches are built over the pipes and are closed at the sides beneath with 4-inch slats set an inch apart. In this way nearly all the heat is applied directly to the soil, only enough escaping through the spaces between the slats to aid somewhat in warming the house, in connection with one run of pipe overhead. We have a good illustration in our houses at the present writing, (Dec. 27), of the accelerating influence of bottom heat. One bench, to which no bottom heat was applied for the first three weeks, is just giving beans fit for picking. On another bench in the same house, to which heat was applied from the first and upon which the same variety was sown at the same date, the second crop of beans has been up for nearly two weeks. The lack of bottom heat delayed the crop fully four weeks. A good bean and cucumber bench is shown in the illustration. The house should be light, and the benches should be near the glass.

If the benches are unoccupied, the beans may be planted on them directly, but if a crop is on them the beans should be started in pots. We like to plant two or three beans in a 3-inch rose pot, and transplant to the benches just as soon as the roots fill the pot.

The night temperature of a bean house ought not to fall below 60°. When the blossoms appear, give a liberal application of liquid manure every five or six days. The growth of beans should be continuous and rapid from the first, in order to secure a large crop of tender pods. The bean is self-fertile, and therefore no pains is necessary to insure pollination, as in the case of tomatoes, and some other in-door crops. The house may be kept moist by sprinkling the walks on bright days.

The essentials of a forcing bean are compact and rapid growth, earliness, productiveness, and long, straight and symmetrical pods. The Sion House answers these requirements the best of any variety which we have yet tried. The cut shows with exactness an average bench of Sion House. English growers recommend the Green Flageolet, and we have had good success with it; but it is about a week later than Sion House, and it possesses no points of superiority. German Wax (*Dwarf German Black Wax*,) forces well, but the pods are too short and too crooked. It is also particularly liable to the attacks of the pod fungus. Newtown (*Pride of Newtown*,) is too large and straggling in growth. We are experimenting with other varieties, including pole beans, but we are not yet ready to report upon them.

For market the beans are sorted, and tied in bunches of 50 pods, as shown in the cut. These bunches bring varying prices, but from 25 to 50 cents may be considered an average. At these figures, with a good demand, forced beans pay well. The enemies are few, red spider being one of the worst, and this is kept in check by maintaining a moist atmosphere. Only three or four pickings of beans can be made profitably from one crop. Much of the success of bean forcing, as of all other winter gardening, consists in having new plants ready to take the place of the old ones. As soon as the old plants are removed, fork up the beds, add a liberal quantity of strong, short manure, and replant immediately.

INFLUENCE OF LATITUDE UPON POTATOES.—A CRITICISM.

During the last year or two a note has gone the rounds of the press to the effect that potatoes grown in the north sprout less in the cellar than those grown in the south. This opinion does not appear to be founded upon experiment, but rather upon a general notion that northern grown seeds and tubers are more tardy in germinating or vegetating, because the northern seasons are more tardy. This is opposed to all the known effects of climate upon plants. Northern grown plants are more sensitive to heat and cold than southern grown, and start relatively earlier in spring. In 1889 I attempted to test this point upon the sprouting of potatoes, and the results of the trial were reported in the *American Garden* for November, 1889, p. 401. Early Rose was grown from Pennsylvania-grown seed and Maine-grown seed. The samples were placed in a moist and light cellar, side by side, and allowed to remain three weeks. When removed, the Maine tubers were so badly sprouted that great difficulty was experienced in removing them from the crate, while the Pennsylvania tubers had only begun to sprout. This result was clear and definite, and it appeared to discredit the common notion that northern-grown potatoes sprout less than others. The Maine potatoes also yielded $4\frac{4}{5}$ more than the others. Experiments made at some other stations have given similar results concerning yields.

A much larger experiment was planned in the same direction this year, and the results are here given as a criticism upon this method of experimentation, which has been practiced by many others as well as ourselves. Ten lots of potatoes were procured and on April 11th they were photographed and placed in identical conditions under a greenhouse bench. The samples were as follows:

Beauty of Hebron.

1. Grown by Pennsylvania Experiment Station.
2. " M. F. Pierson, Ontario Co., N. Y.
3. " S. Frogner, Herman, Minn.
4. " Geo. W. P. Jerrard, Caribou, Me.

Early Rose.

5. Grown by Pennsylvania Experiment Station.
6. Grown in Western New York.
7. Grown by S. Frogner, Herman, Minn.
8. " Geo. W. P. Jerrard, Caribou, Me.

White Elephant.

9. Grown by M. F. Pierson, Ontario Co., N. Y.
10. " Geo. W. P. Jerrard, Caribou, Me.

None of the potatoes were sprouted when put in storage. May 22d they were removed and photographed and notes were taken. In the Beauty of Hebron lot, the longest and most numerous sprouts occurred in Nos. 1 and 2, the southernmost seed. In the Early Rose lot there were no marked differences. In the White Elephant lot, the northern seed gave much the fewest and shortest sprouts. Or, in other words, the test as a whole gave no pronounced results, although the southernmost seeds gave somewhat longer sprouts on the average.

The yields are as follows, from ½ bushel of seed in each case:

Beauty of Hebron.

No. 1.	Penn.,	33 lbs.
" 2.	N. Y.,	34 "
" 3.	Minn.,	44 "
" 4.	Maine,	93 "

These figures agree with the results of 1889, and if we had gone no farther we might have said unqualifiedly that northern-grown seed is best.

Early Rose.

No. 5.	Penn.,	123 lbs.
" 6.	N. Y.,	57 "
" 7.	Minn.,	32 "
" 8.	Maine,	126 "

These figures show that the two extremes gave best results. If we had not chanced to have grown the Maine seed we might have inferred that southern-grown seed is best.

White Elephant.

No. 9.	N. Y.,	98 lbs.
" 10.	Maine,	161 "

This indicates again that northern-grown seed is best.

All these figures are invaluable, it seems to me, in showing that this is an entirely unreliable method of experimentation and that isolated results are not to be depended upon. The variations in these potatoes were no doubt due much more to the stock itself —how it had been grown and handled in previous years—than to any influences of latitude. In other words, I believe that it is impossible to secure stock from different growers which is uniform enough to allow of comparative experimentation ; and this is as true in other plants as in potatoes. If this generalization is correct, we must modify many of our methods of experimentation. In order to secure a uniform stock, it must be grown in the same place and under the same conditions for several years, and this can then be distributed to various growers and after a time returned to be grown again side by side for comparison. And even here it will be difficult to eliminate uncertainties. But in this line we shall now work upon our studies of the influence of latitude upon plants.

NOTES UPON METHODS OF HERBACEOUS GRAFTING.

My attention has been called a number of times to the unsatisfactory records and directions concerning the grafting of herbaceous plants. There appears to have been very little attention given to the subject, and the scant discussions of it are mostly copied from one author to another. A few years ago I made some attempts at herbaceous grafting, but it was not until last winter that experiments were seriously undertaken. The work was put in the hands of J. R. Lochary as a subject for a graduating thesis.

The experiments were undertaken primarily for the purpose of learning the best methods of grafting herbs, but a secondary and more important object was the study of the reciprocal influences of stock and cion, particularly in relation to variegation and coloration. This second feature of the work is still under way, in one form or another, and we hope for definite results in a few years. As a matter of immediate advantage, however, herbaceous grafting has its uses, particularly in securing different kinds of foliage and flowers upon the same plant. There is no difficulty in growing a half dozen kinds or colors, on geraniums, chrysanthemums, or other plants from one stock of the respective species.

Six hundred grafts were made in our trials last winter. It was found that the wood must be somewhat hardened to secure best results. The very soft and flabby shoots are likely to be injured in the operation of grafting, and union does not take place readily. Vigorous coleus stocks three months old, gave best results if cut to within two or three inches of the pot and all or nearly all the leaves removed from the stump. Geraniums, being harder in wood, made good unions at almost any place except on the soft growing points. The stock must not have ceased growth, however. Most of the leaves should be kept down on the stock. Cions an inch or two long were usually taken from firm growing tips, in essentially the same manner as in the making of cuttings. Sometimes an eye of the old wood was used, and in most cases union took place and a new shoot arose from the bud. The leaves were usually partly removed from the cion.

Various styles of grafting were employed, of which the common cleft and the veneer or side graft were perhaps the most satisfactory. In most instances it was only necessary to bind the parts together snugly with bass or raffia. In some soft-wooded plants, like coleus, a covering of common grafting wax over the bandage was an advantage, probably because it prevented the drying out of the parts. In some cases, however, wax injured the tissues where it overreached the bandage. Sphagnum moss was used in many cases, tied in a small mass about the union, but unless the parts were well bandaged the cion sent roots into the moss and did not unite ; and in no case did moss appear to possess decided advantages. Best results were obtained by placing the plants at once in a propogating-frame, where a damp and confined atmosphere could be maintained. In some plants, successful unions were made in the open greenhouse, but they were placed in shade and kept sprinkled for a day after the grafts were made. The operation should always be performed quickly to prevent flagging of the cions. Or, if the cions cannot be used at once, they may be thrust into sand or moss in the same manner as cuttings, and kept for several days. In one series, tomato and potato cuttings, which had flagged in the cutting bed, revived when grafted. And cuttings which had been transported in the mail for three days grew readily, but they were in good condition when received. The mealy bugs were particularly troublesome upon these grafted plants, for they delighted to crawl under the bandages and suck the juices from the wounded surfaces.

Although it is foreign to the purpose of this note, it may be worth while to mention a few of the plants upon which the experiments were made. Sections were taken of many of the grafts and microscopic examinations made to determine the extent of cell union. Coleuses of many kinds were used, with uniform success, and the cions of some of them were vigorous a year after being set. Even iresine, (better known as *Achyranthes Verschaffeltii*,) united with coleus and grew for a time. Zonale geraniums bloomed upon the common rose geranium. Tomatoes upon potatoes and potatoes upon tomatoes grew well and were transplanted to the open ground, where some of them grew, flowered and fruited until killed by frost. The tomato-on-potato plants bore good tomatoes above and good potatoes beneath, even though no sprouts from the potato stock were allowed to grow. Peppers united with tomatoes and tomatoes united with peppers. Egg plants, tomatoes and peppers grew upon the European husk tomato or alkekengi (*Physalis Alkekengi*). Peppers and egg plants united with each other reciprocally. A coleus cion was placed upon a tomato plant and was simply bound with raffia. The cion remained green and healthy and at the end of forty-eight days the bandage was removed, but it was found that no union had taken place. Ageratums united upon each other with difficulty. Chrysanthemums united readily. A bean plant, bearing two partially grown beans, chanced to grow in a chrysanthemum pot. The stem bearing the pods was inarched into the chrysanthemum. Union took place readily, but the beans turned yellow and died. Pumpkin vines united with squash vines, cucumbers with cucumbers, musk-melons with watermelons, and musk-melons, watermelons and cucumbers with the wild cucumber or balsam apple (*Echinocystis lobata*).

Another interesting feature of the work was the grafting of one fruit upon another, as a tomato fruit upon a tomato fruit or a cucumber upon another cucumber. This work is still under progress and it promises some interesting results in a new and unexpected direction, reports of which may be expected later.

THE INFLUENCE OF DEPTH OF TRANSPLANTING UPON THE HEADING OF CABBAGES.

Nearly all gardeners suppose that deep setting of cabbage plants is essential to success. The plants are set in the ground up to the lowest leaves when transplanted from the seed-bed. Tests were made upon this point in 1889 with thirteen varieties, and the results showed no appreciable difference between the deep set plants and those set at the natural depth. (These results appeared in BULLETIN XV, page 209.) The test was repeated this year upon Early Wakefield (*Early Jersey Wakefield.*) Over two hundred plants, for which the seeds were sown under glass April 14th, were set in the field May 29th. They were set in six parallel rows, every other row containing plants set at the same depth as they stood in the seed-bed, and the alternate ones containing those set down to the first leaves. The soil was a heavy clay loam, unfertilized. The crop was harvested Aug. 1st and Aug. 23d, and the following figures were obtained :

	No. of Plants.	No. of Mature or Solid hds.	Per cent. of Pl'ts producing Mature hds.	Average weight per hd.
Deep	107	82	**77**	**1.6** lbs.
Shallow	104	89	**85**	**1.8** "

Shallow planting gave better results than deep planting, both in the percentage of good heads and in the weight of heads. In 1889, in a larger experiment, the comparative results of the two methods were indifferent. We feel, therefore, that the common notion that deep transplanting is essential to success in cabbage growing is at least doubtful.

THE PEACH YELLOWS.

The yellows of the peach is spreading in Western New York, and it is becoming a very serious menace to peach culture. Investigations into the nature of this disease have been carried on for the last three or four years by the Department of Agriculture at Washington. Little has been said concerning these investigations, and people are not aware of the extent to which they have been carried. In order to learn something of their scope, I visited the

Chesapeake Peninsula in October and examined the field experiments under progress. Dr. E. F. Smith is the special agent of the Department of Agriculture, who is investigating the disease. In this region he has eighty acres of orchard under direct experiment, forty of which, scattered through twelve orchards in Delaware and Maryland, are devoted to fertilizer tests. These fertilizer tests are above a hundred in number, and comprise treatment with nitrogen, potash, and phosphorus, and many combinations of them. He has tried all of the fertilizer remedies which have been recommended for the cure of the disease and for its prevention. These have been tried upon all kinds of soils, and upon trees of all ages. They have been used with exceeding care, and they comprise the largest field experiments of this nature, upon diseases of plants, yet made in this country. It is evident upon examining these orchards that there is no fertilizer nor combination of fertilizers which will either cure or prevent the yellows. Many of the fertilizers, especially those rich in nitrogen, have a wonderful effect upon the vigor of the tree, but they do not prevent the yellows, nor cure it. All the investigations so far made, go to show that yellows is a specific disease, entirely independent of soil or surroundings.

Many investigations in other directions have been made, and many important facts have been obtained concerning the nature of the disease, but so far its cause has not been determined. The disease is an exceedingly obscure one, much more so than pear blight or any other disease with which we are familiar.

The New Jersey, Delaware and Maryland orchards are being rapidly decimated with the yellows ; in fact, the upper portion of Delaware is practically devastated of peach trees, and the upper part of the Chesapeake Peninsula in Maryland is no longer a profitable peach region. There are acres upon acres of orchard in which more than every other tree is visibly diseased, and in large areas it is almost impossible to find a single healthy tree. There has been very little united attempt toward controlling the yellows in these regions, and for that reason this present destruction threatens the industry. It is useful to compare the results in this region with those of the Michigan peach region, where a definite law was early enacted and which has been enforced vigorously. In Michigan the yellows is on the decrease and the planting of orchards is on the increase. In Maryland and Delaware,

the yellows is rapidly on the increase and orcharding is mostly on the decrease. The only remedy so far known is eradication of the tree as soon as the disease is seen. The disease is constitutional, and even when we have found the cause it will probably remain incurable. Yet there is no reason for undue alarm in the matter, because the experience of the Michigan growers has proved conclusively that radical measures will keep the disease in check or almost eliminate it from any country. The New York law is essentially the same as the Michigan law, and if it is rigidly enforced by healthy public sentiment, there is no reason why peach culture should not flourish. Otherwise, sooner or later our peach industry must perish.

THE PAPER FLOWER POT.

F. W. Bird & Son, East Walpole, Mass., have sent us for trial an assortment of paper flower pots. These are made chiefly for the shipping trade, to save breakage, and lessen transportation charges. Two months ago we potted off a number of conservatory plants in some of these pots, and then plunged them in sphagnum moss, alongside earthen pots. The moss has been kept wet, yet the pots are still in good condition, and the plants are growing well. A number of plants were transferred to paper pots, and were expressed to Professor C. S. Crandall, Fort Collins, Col. The plants were ten days on the road. Professor Crandall wrote: "The pots were in good condition, and apparently capable of standing even a longer journey. None of them came apart, and unless moisture were used in excess, I see no reason why they would not answer admirably for shipping any distance."

The paper pot appears to be a good thing, both in which to ship plants, and in which to grow rapidly growing stock for sale.

EXPERIENCES IN CROSSING CUCURBITS.

The limits and results of crossing among cucurbitaceous plants —pumpkins, squashes, melons, cucumbers—are little understood. The common notions are exceedingly vague. It is nearly everywhere supposed that all the species intermingle indiscriminately, and any statement to the contrary is likely to meet with incredulity. Yet there is reason to believe that many of the com-

mon observations concerning these plants are incorrect. All the species are exceedingly variable, and it is easy to select fruits from large plantations which bear some external resemblance to fruits of other species, and it is natural to suppose, in the present confused state of our knowledge of hybridity, that such fruits are hybrids.

I began definite experiments in crossing cucurbits in 1887, and selections and close observations were begun before that time. The work has been continued upon a large scale, and I have now made fully 1,000 careful hand pollinations, and have obtained no less than 1,000 types of pumpkins and squashes never recorded. The plantations of selections and crosses covered some eight acres this year.

The experiment is only begun. The main results of it can not be announced until further work has been done. But some of the incidental features of the research can be stated from time to time.

1. *Immediate effect of crossing.*—The "immediate effect of crossing" is a term used to denote any change which may occur in the fruit the same year the cross is made, as a result of the influence of pollen. Whatever effect the pollen may have is usually shown in the offspring of the crossed fruit rather than immediately, the same season, in the fruit itself. There are but few plants in which an immediate effect of crossing has been proved, and of these Indian corn is the most familiar. It is commonly said that it occurs in pumpkins and squashes, also; but it certainly does not. There has never been any immediate influence whatever in any of our crosses, except such as was due to imperfect development caused by insufficient or impotent pollen. In other words, the effects of the cross are seen only in the offspring of the fruits.

It is easy to prove, without the aid of artificial pollination, even among the most variable squashes, that there is no immediate effect. If there were an immediate effect, all the fruits upon a vine would be likely to be different, as every one would probably receive a different pollination. This diverse pollination would almost inevitably result if many varieties were planted close together, for the flowers of pumpkins and squashes are imperfect and cannot pollinate themselves. But the fact is that all the fruits on any vine are alike, with some trifling exceptions in rare cases due to arrested development or the like: the essential char-

acters of the fruits are the same. This shows that the character of the vine is determined by the character of the seed from which it comes. My observation shows that this is invariably the case.

There is no reason, therefore, to suppose that there is ever any immediate effect of crossing in pumpkins and squashes.*

2. *Do pumpkins and squashes mix?*—No one appears to doubt the indiscriminate mixing of pumpkins and squashes. Before considering the question, it is necessary to divide the fruits called squashes into two groups. One group includes the summer and fall squashes, like the scallops, common crooknecks, cocoa-nut, Bergen, and the like; these belong to the same species as the field pumpkin, *Cucurbita Pepo*. These squashes cross with the ordinary field pumpkin and with each other, although the mixing even here does not appear to be indiscriminate. The other group includes the Hubbard, Marblehead, turbans, and the so-called mammoth squashes and pumpkins like Mammoth Chili and Valparaiso; these belong to a distinct species, *Cucurbita maxima*. Many careful pollinations have been made between these two classes of fruits, and in no case have seeds been procured. Sometimes the fruit will develop for a time, and in two or three instances a summer crookneck pollinated by a turban squash has developed until half grown, and has then persisted until the end of the season, but it was seedless. All our experiments show that *Cucurbita Pepo* and *C. maxima* do not hybridize.

It is an easy matter to find fruits in any large assortment of pumpkins or summer squashes which might be taken for hybrids with the Hubbard or turbans by a casual observer. But none of these fruits which have come under my observation—and I have seen hundreds—possess any marks of hybridity, and they have occurred in our experiments among pedigree stock which had no *Cucurbita maxima* blood in it. These so-called hybrids are nothing more than incidental variations of *Cucurbita Pepo*, and they may appear anywhere at any time.

Our experience and observation show, therefore, that the field pumpkins and the summer and fall types of bush squashes do not

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* The same observation can be made with reference to blackberries and raspberries. Over 250 successful hand pollinations were made this year between blackberries, raspberries and dewberries in many combinations, and there were no immediate effects.

mix with the running squashes of the Hubbard, Marblehead, Boston Marrow, turban and mammoth types.

3. *Impotency of individual pollinations.*—In pumpkins and squashes the flowers are either wholly staminate or wholly pistillate, and they cannot, therefore, pollinate themselves. But the two kinds of flowers are borne upon the same plant. Pollination between two flowers upon the same plant I have termed *individual pollination*, in distinction from close pollination, or pollination of the flower by itself, and from cross pollination, or pollination between flowers on different plants. It has been shown by Darwin and others that pollen is sometimes impotent upon the pistil of the same flower, and I have been much interested, therefore, in the relation of pollen to pistils upon the same plant in monœcious species (those in which the sexes are borne in different flowers upon the same plant). My attention was first called to this subject in 1889, when some twenty or thirty squash flowers were pollinated from flowers on the same plant. A number of fruits grew to maturity, but they invariably produced poor seeds. This year the subject was carefully examined. 185 squash and gourd flowers of some fifty varieties were individually pollinated. 163 of these did not produce fruit. The remaining 22 carried fruits to maturity, but in every case the seeds were thin and worthless. These 22 fruits represented 13 bush summer squashes of various kinds, 5 small ornamental gourds, and four crosses between bush squashes and gourds. In cross pollinations made during the same time and in the same manner, a large part of the crosses were successful, indicating that the failure of the individual crosses was due to the inability of the pollen to fertilize the ovules rather to incidental methods of operation. The experiment indicates that pollen of squashes which cannot produce fertile seeds may still cause the development of the fruit. This influence of pollen is well attested in other instances, but it is not impossible that squashes may sometimes develop without any pollination whatever. At any rate we have found this to be the case in some other cucurbits, and it is a point upon which we are still working, and concerning which we have much data.

This impotency of individual pollen is a matter of immense importance to originators of varieties. It is commonly held that the best way in which to "fix" or render permanent new varieties, so that they will reproduce themselves by seedage, is to in-breed

or close pollinate them, but the above trials indicate that this is impossible or practically so in pumpkins and squashes. An instance in my own experience is suggestive. From stock which was crossed in 1887, I obtained in 1889 one squash of great excellence. It appeared to combine more good qualities than any squash of its type that I have ever seen. To procure as many plants of it as possible, in order to cross and fix it, I planted all the seeds from the best fruit in the spring of 1890. These seeds, all from one squash, produced 110 distinct varieties, and only one plant was like the parent! The only thing to do was to pollinate the flowers of this one plant with pollen from itself, but it soon became evident that all of these individual pollinations would fail. It was then necessary, late in the season, to pollinate the remaining flowers from some other plant which bore fruit the nearest like the one under experiment. Fortunately, two or three other plants bore similar fruits, and by the use of their pollen two good fruits were obtained.

It appears, therefore, that in squashes and pumpkins the pollen is impotent upon pistils on the same plant, and that true inbreeding does not occur in them. The experiment will be extended to all varieties.

4. *Do cucumbers spoil musk-melons?*—If any dogma finds general acceptance among horticulturists, it is the opinion that musk-melons are rendered insipid and worthless by cucumbers growing in their vicinity. Most growers suppose that this influence is immediate, but a few hold that it appears only in the offspring of supposed crosses between the two species. Several years ago my observations led me to doubt this influence, but definite experiments were not undertaken until last winter, when a house of forced melons and cucumbers gave a good opportunity to make cross pollinations. In these trials we failed to produce melons when the flowers were pollinated either by the common white spine or the English forcing cucumbers.

Last summer the work was undertaken in the garden under the best of opportunities. Ninety-seven musk-melon flowers of various varieties were pollinated by cucumber pollen of many kinds. No fruits developed. Twenty-five cucumber flowers were pollinated by musk-melon pollen. Only one fruit developed, and that was seedless. These figures certainly indicate that melons and cucumbers do not cross, and therefore that the influence of one

upon the other is fictitious. It has been suggested by one who has followed this experiment that even if the cucumber pollen will not fertilize the musk-melon, it may still exert a sort of secondary influence if applied along with musk-melon pollen. But if the cucumber pollen does not even possess the power of developing the fruit walls, as our experiments show, it is inconceivable that it should exert any influence whatever. The single seedless fruit of cucumber which developed in the musk-melon pollinations, does not prove that musk-melon pollen will cause the development of the fruit walls of the cucumber, for our experiments have shown conclusively that cucumbers will often develop to full size without any pollination whatever.* Those who make experiments in the pollination of musk-melons must bear in mind that some varieties bear perfect flowers, and the anthers must be removed before the flower opens.

Our experience indicates, therefore, that the common opinion that cucumbers spoil musk-melons is, at least, exceedingly doubtful.

5. *Progression of flowers.*—When I first began to cross the cucurbits I noticed that all plants produce far more staminate than pistillate flowers, and that the staminate flowers appear much earlier in the season than the pistillate. A study of Hubbard and Boston Marrow squashes in 1887 showed that pistillate flowers rapidly decreased in numbers during a prolonged drouth. Records were also kept of the number and time of appearing of the flowers of each sex in other cucurbits, but as those records were not published, I have had similar ones made this year. All the flowers were counted as they appeared upon two musk-melon plants, one water-melon and one cucumber plant. These plants were all treated to ordinary garden conditions ; no pollinations were made upon them, and no flowers were removed, so that their characteristics as recorded below are entirely normal. In forcing cucurbits in winter, such as cucumbers, musk-melons, summer squashes and benincasa, I have invariably noticed this same disposition to form staminate flowers first and most abundantly.

* The matter of cucumber pollination, together with notes upon the forcing of cucumbers, will form the subject of a future bulletin.

RECORD—1890.

	Musk Melon. No. 1.		Musk Melon. No. 2.		Water Melon.		Cucumber.	
	Staminate	Pistillate	Staminate	Pistillate	Staminate	Pistillate	Staminate	Pistillate
July 29	1	. .	3	. . .	. . .	. . .	4	. . .
30	1	. . .	—	. . .	. . .	. . .	2	. . .
31	1	. . .	—	. . .	. . .	. . .	3	. . .
Aug. 1	1	. . .	1	. . .	. . .	. . .	3	. . .
2	3	. . .	2	. . .	2	. . .	6	1
3	3	. . .	—	. . .	1	. . .	7	1
4	2	. . .	1	. . .	—	. . .	9	. . .
5	7	. . .	3	. . .	1	. . .	10	. . .
6	4	. . .	5	. . .	1	. . .	16	. . .
7	4	. . .	3	. . .	1	1	18	. . .
8	2	. . .	2	. . .	2	. . .	14	1
9	11	. . .	5	. . .	5	. . .	11	2
10	8	. . .	4	. .	3	2	17	. . .
11	9	. . .	4	1	3	1	21	2
12	18	. . .	3	. . .	5	. . .	33	1
13	10	. . .	2	. . .	2	. . .	27	1
14	12	. . .	3	. . .	6	3	16	. . .
15	8	. . .	6	. . .	6	. . .	23	. . .
16	17	. . .	5	1	5	1	18	. . .
17	17	. . .	1	1	9	4	24	. . .
18	15	. . .	4	3	7	1	20	. . .
19	16	. . .	2	. . .	12	1	29	. . .
20	8	. . .	4	. . .	5	. . .	37	. . .
21	7	. . .	2	. . .	3	. . .	14	. . .
22	31	. . .	3	. . .	10	1	18	1
23	6	. . .	1	1	5	. . .	20	. . .
24	7	. . .	2	. . .	6	. . .	22	. . .
25	10	. . .	2	. . .	6	2	13	. . .
26	4	. . .	2	. . .	5	. . .	21	. . .
27	14	2	1	2	10	2	15	. . .
28	11	4	5	2	9	. . .	21	. . .
29	16	2	8	. . .	14	. . .	23	. . .
30	6	1	4	1	5	1	15	. . .
31	8	1	3	. . .	10	2	10	. . .
Sept. 1	1	1	3	. . .	9	1	15	1
2	3	. . .	4	1	2	. . .	12	. . .
3	13	. . .	4	. . .	10	. . .	6	. . .
4	24	. . .	7	1	15	. . .	30	2
5	7	. . .	6	1	9	. . .	17	. .
6	15	. . .	12	1	3	. . .	9	1
7	18	. . .	12	3	1	. . .	13	. . .
8	29	. . .	2	3	2	. . .	18	. . .
9	24	4	18	2	. . .	. . .	8	1
10	30	2	12	3	. . .	. .	13	. . .
11	35	1	23	3	. . .	. . .	12	1
12	3	. . .	—	—	. . .	. . .	3	2
13	10	. . .	1	1	. . .	. . .	4	1
14	47	3	15	3	. . .	. . .	5	3

RECORD, 1890—CONTINUED.

	Musk Melon. No. 1.		*Musk Melon. No. 2.*		*Water Melon.*		*Cucumber.*	
	Staminate	Pistillate	Staminate	Pistillate	Staminate	Pistillate	Staminate	Pistillate
Sept. 15	28	2	26	3	. . .	. . .	11	3
16	17	1	8	1	. . .	. . .	6	2
17	21	3	4	3	. . .	. . .	3	2
18	19	1	7	1	. . .	. . .	6	1
19	7		2	1	. . .	. . .	6	3
20	6	Plant	3	4	1	. . .	4	8
21	6	begins	5	2	. . .	. . .	6	5
22	5	to fail.	19	—	. . .	. . .	5	4
23	4		20	1	. . .	. . .	13	3
24 *Frost.*	. . .	. . .	5	1	. . .	. . .	6	1
25	. . .	. . .	1	—	. . .	. . .	4	. . .
26	. . .	. . .	—	1	. . .	. .	8	. . .
27	. . .	. . .	1	1	. . .	. . .	2	. . .
28	. . .	. . .	. . .	. . .	. . .	. . .	1	. . .
29	. . .	. . .	. . .	. .	. . .	. . .	1	. . .
Totals	670	28	316	53	211	23	807	54

These figures are full of significance. They show that the staminate, or male flowers, are more numerous in each case than the pistillate, or fertile flowers, ranging from 6 to 24 times as many. They show that the pistillate flowers make their appearance later in the season—from five days in the cucumber to thirty days in one of the musk-melons. They also show that as a rule the staminate flowers continue to appear later in fall than the pistillate. Musk-melon No. 1 was a weaker plant than the others, and it began to fail by the middle of September. It is, therefore, instructive to observe that in this plant the proportion of pistillate flowers was the smallest, and that they appeared later and ceased earlier than the other plants. And the figures illustrate the common observation that the cucumber is more precocious than the melons. The figures show forcibly the necessity of starting melons early in our short seasons.

L. H. BAILEY.

APPENDIX II.

Detailed statement of the receipts and expenditures of the Cornell University Agricultural Experiment Station, for the fiscal year ending June 30, 1890.

RECEIPTS.

FROM AGRICULTURAL DIVISION.

1889.			
Nov.	2.	Wool sold,	$ 14 89
1890.			
Jan.	7.	Pork sold,	6 92
Feb.	5.	"	11 84
"	6.	Mutton sold,	4 83
		Total from Agricultural Division,	$ 38 48

FROM HORTICULTURAL DIVISION.

1889.			
Nov.	8.	Sundries,	$ 129 42
Dec.	11.	Sundries,	88 05
1890.			
Jan.	1.	Hauling coal,	6 00
"	10.	Sundries,	4 00
Feb.	1.	Hauling coal,	25 86
Mch.	1.	" "	26 10
"	8.	Sundries,	4 92
April	1.	Hauling coal,	41 55
May	5.	Coal returned,	5 04
"	10.	Sundries,	33 50
June	30.	"	27 88
		Total from Horticultural Division,	$ 392 32

FROM PRINTING ACCOUNT.

1889.			
Aug.	5.	Rebate on Tennessee Bulletin,	2 85
Oct.	29.	Rebate on drawings, Bulletin IX,	18 00
		Total from Printing Account,	$ 20 85

FROM OFFICE ACCOUNT.

1890.			
June	30.	Exchange,	$ 1 97
		Total from Office Account,	$ 1 97

EXPENDITURES.

FOR SALARIES.

1889.			
Oct.	1.	I. P. Roberts, Director, 1 qr.,	$ 375 00
"	1.	H. H. Wing, Deputy Director, 1 qr.,	500 00
"	1.	L. H. Bailey, Horticulturist, 1 qr.,	500 00
"	1.	Ed Tarbell, Asst. Agriculturist, 1 qr.,	187 50
"	1.	W. P. Cutter, Asst. Chemist, 1 qr.,	250 00
"	1.	J. M. Stedman, Asst. Entomologist, 1 qr.,	250 00
"	1.	W. M. Munson, Asst. Horticulturist, 1 qr.,	250 00
"	1.	W. R. Dudley, Crypto. Botanist, 1 qr.,	250 00
1890.			
Jan.	1.	I. P. Roberts, Director, 1 qr.,	375 00
"	1.	H. H. Wing, Deputy Director, 1 qr.,	500 00
"	1.	L. H. Bailey, Horticulturist, 1 qr.,	500 00
"	1.	Ed Tarbell, Asst. Agriculturist, 1 qr.,	187 50
"	1.	W. P. Cutter, Asst. Chemist, 1 qr.,	250 00
"	1.	J. M. Stedman, Asst. Entomologist, 1 qr.,	250 00
"	1.	W. M. Munson, Asst. Horticulturist, 1 qr.,	250 00
"	1.	W. R. Dudley, Crypto. Botanist, 1 qr.,	250 00
April	1.	I. P. Roberts, Director, 1 qr.,	375 00
"	1.	H. H. Wing, Deputy Director, 1 qr.,	500 00
"	1.	L. H. Bailey, Horticulturist, 1 qr.,	500 00
"	1.	Ed Tarbell, Asst. Agriculturist, 1 qr.,	187 50
"	1.	J. M. Stedman, Asst. Entomologist, 1 qr.,	250 00
"	1.	W. P. Cutter, Asst. Chemist, 1 qr.,	250 00
"	1.	W. M. Munson, Asst. Horticulturist, 1 qr.,	250 00
"	1.	W. R. Dudley, Crypto. Botanist, 1 qr.,	250 00
May	20.	W. P. Cutter, Asst. Chemist, 1⅔ months,	138 89
June	30.	I. P. Roberts, Director, 1 qr.,	375 00
"	30.	H. H. Wing, Deputy Director, 1 qr.,	500 00
"	30.	L. H. Bailey, Horticulturist, 1 qr.,	500 00
"	30.	Ed Tarbell, Asst. Agriculturist, 1 qr.,	187 50
"	30.	J. M. Stedman, Asst. Entomologist, 1 qr.,	250 00
"	30.	W. M. Munson, Asst. Horticulturist, 1 qr.,	250 00
"	30.	W. R. Dudley, Crypto. Botanist, 1 qr.,	250 00
"	30.	Harry Snyder, Asst. Chemist, 1⅓ months,	83 33
		Total for Salaries,	$10,222 22

FOR BUILDINGS.

1889.			
July	3.	Herendeen Mfg. Co., Steam Fitting,	$ 75 00
Oct.	19.	Charles Phillips, labor,	13 78
"	19.	Simeon Knettles, labor,	18 20
"	19.	John Granville, labor,	4 50
"	26.	G. W. Sherman, labor,	32 30
"	26.	Charles Phillips, labor,	8 10
Aug.	28.	Jamieson & McKinney, Repairs to Insectary,	29 86
Nov.	2.	Charles Phillips, labor,	7 87
"	2.	Simeon Knettles, labor,	4 80
"	2.	Patrick Hennessy, labor,	6 00
"	2.	James Carmody, labor,	4 50
"	2.	F. W. Card, labor,	2 85
"	2.	W. J. MacNeil, labor,	4 02
"	5.	G. H. Nelson, Painting and Glazing,	72 00
		Amount carried forward,	$ 283 78

		Amount brought forward,	$ 283 78
Nov.	19.	W. H. Kavanagh, acc't Steam Heating Contract, . . .	75 00
"	9.	Treman, King & Co., Storm Sash and Glass (Insectary),	9 84
Dec.	7.	White & Burdick, Paint, ...	2 50
"	7.	Wm. H. Kavanagh, acc't Steam Fitting, ...	25 00
"	24.	Wm. H. Kavanagh, bal. Steam Fitting, ...	36 00
Nov.	2.	Geo. Small, Lumber, Forcing House, ...	206 77
Oct.	9.	Treman, King & Co., Hardware, Forcing House, ...	111 10
		Total for Buildings, ...	$ 749 99

FOR PRINTING.

1889.			
Aug.	14.	W. S. Holdsworth, Drawings, Bull. IX, ...	$ 10 00
"	24.	Andrus & Church, 20,000 Manilla Envelopes, ...	62 00
"	24.	" " 10,000 copies Bull. VIII, ...	119 72
"	15.	Lewis Engraving Co., Plates, Bull. IX, ...	3 73
"	23.	" " " " "	7 20
Sept.	30.	Andrus & Church, 10,000 copies Bull. IX, ...	197 75
Oct.	9.	W. S. Holdsworth, Drawings, Bull. X, ...	12 00
"	12.	National Exp. Co., Expressage, ...	40
"	10.	Lewis Eng. Co., Plates, Bull. X, ...	7 35
Nov.	7.	Adams Exp. Co., Expressage, ...	25
"	18.	Andrus & Church, 7,500 copies Bull. X, ...	137 00
"	20.	C. H. Howes, Photographs, Bull. XIII, ...	1 08
"	19.	Lewis Eng. Co., Plates, Bull. XI, ...	15 34
"	26.	Adams Exp. Co., Expressage, ...	25
Dec.	2.	National Exp. Co., "	25
"	9.	Miss Edna Porter, Drawings, Bull. XIV, ...	4 00
"	7.	Lewis Eng. Co., Plates, Bull. XIII, ...	6 66
"	11.	National Exp. Co., Expressage, ...	35
"	11.	W. S. Holdsworth, Drawings, Bull. XIII, ...	15 00
"	19.	National Exp. Co., Expressage, ...	40
"	20.	Andrus & Church, 7,000 copies Bull. XI, ...	120 67
"	28.	" " 1,500 " XII, ...	16 77
"	18.	Lewis Eng. Co., Plates, Bull. XIII and XIV, ...	19 91
1890.			
Jan.	3.	National Exp. Co., Expressage, ...	25
"	4.	Andrus & Church, 8,000 copies Bull. XIII, ...	123 40
"	2.	Lovejoy Co., Plates, Bull. XV, ...	1 72
"	9.	Anna B. Comstock, Drawing, Bull. XI, ...	9 00
"	9.	" " " and Engraving, Bull. XV,	9 00
"	9.	Lewis Eng. Co., Plates, Bull. XV, ...	1 65
"	11.	Andrus & Church, 7,000 copies Bull. XIV, ...	78 98
"	11.	" " 500 copies add., Bull. XII, ...	11 50
"	15.	Lewis Eng. Co., Plates, Bull. XV, ...	4 71
"	23.	American Garden, Duplicate Electrotype, ...	1 00
"	13.	F. H. Noyes, Drawings, Bull. XII, ...	3 50
Mch.	5.	Andrus & Church, 8,000 copies Bull. XV, ...	192 00
"	21.	" " 650 copies Annual Report, ...	243 23
April	25.	" " paid expressage, ...	50
"	24.	Binghamton Pub. Co., 12,000 colored Plates, Bull. XVI,	61 50
"	22.	W. S. Holdsworth, Drawing; Bull. XV, ...	3 50
May	10.	Andrus & Church. 12,000 copies Bull. XVI, ...	168 50
"	16.	Lewis Eng. Co., Plates, Bull. XVII, ...	2 02
June	10.	Andrus & Church, 8,000 copies Bull. XVII, ...	87 35
		Total for Printing, ...	$1,762 39

FOR OFFICE EXPENSES.

1889.			
July	6.	Ithaca Gas Light Co., Gas for June,	$ 38
"	25.	H. N. Reid, labor,	60
"	30.	National Exp. Co., Expressage,	25
Aug.	9.	Ithaca Gas Light Co., Gas for July,	38
"	17.	H. N. Reid, labor,	2 18
"	22.	Orange Judd Co., Books,	57
"	27.	National Exp. Co., Expressage,	45
Sept.	5.	J. E. Rice, labor,	2 17
"	21.	B. W. Davis, labor,	60
"	9.	Andrus & Church, Stationery,	50
"	27.	I. P. Roberts, delivery of Telegram,	25
"	26.	Frank Wilson, 3 Keys,	75
Oct.	3.	Postmaster, Stamps,	10 00
"	4.	Andrus & Church, Stationery,	3 75
"	5.	Ithaca Gas Light Co., Gas for Sept.,	19
"	10.	Andrus & Church, Towels and Soap,	1 15
Sept.	14.	Jamieson & McKinney, Water connections,	7 00
Oct.	31.	U. S. Exp. Co., Expressage,	30
"	30.	E. C. Bridgman, N. Y. State Map,	8 00
Nov.	9.	H. N. Reid, 1 Key,	25
Oct.	25.	E. M. Hall, 56 yards Linoleum,	28 00
Nov.	19.	Andrus & Church, Stationery,	4 30
"	25.	" " "	65
"	30.	Adams Exp. Co., Expressage,	50
Dec.	5.	Ithaca Gas Light Co., Gas for Nov.,	19
"	1.	I. P. Roberts, Travelling expenses to Washington,	35 20
"	23.	Andrus & Church, paid Expressage,	30
"	26.	Lovejoy Co., Duplicate Electros,	2 01
"	17.	W. U. Telegraph Co., Telegrams,	70
Oct.	3.	Treman, King & Co., Mail-box,	50
Dec.	19.	Andrus & Church, Stationery,	1 01
1890.			
Jan.	3.	Postmaster, Stamps,	8 00
Jan.	15.	Andrus & Church, Stationery,	25
"	15.	Geo. Rankin & Son, Lamp Shade,	50
"	16.	Andrus & Church, 20,000 Envelopes,	62 00
"	20.	" " Stationery,	50
"	21.	" " "	2 00
Feb.	1.	H. N. Reid, labor,	98
"	1.	Chas. Moore, labor,	1 65
"	1.	Geo. Bradley, labor,	2 55
"	12.	Andrus & Church, Stationery,	60
"	12.	W. O. Wyckoff, Typewriter Ribbon,	1 00
"	15.	Postmaster, Stamps,	2 00
"	28.	Andrus & Church, Stationery,	1 17
Mar.	7.	Postmaster, Stamps,	11 00
"	5.	Andrus & Church, Stationery,	28 25
"	12.	H. P. Matthews, labor,	2 89
"	7.	Ass'n Am. Agr. Coll. and Exp. Sta., dues 1889–1890,	10 00
"	18.	H. N. Reid, labor,	60
"	15.	Andrus & Church, Stationery,	9 57
"	24.	I. P. Roberts, Telegram,	55
"	21.	" " delivery 3 Telegrams,	75
"	31.	Andrus & Church, Stationery,	36
April	1.	Webb's Adder Co., 1 Adder,	7 14
		Amount carried forward,	$ 267 39

		Amount brought forward,	$ 267 39
April	25.	J. E. Rice, labor,	3 82
"	23.	Andrus & Church, 20,000 Envelopes,	62 00
May	7.	Postmaster, Stamps,	5 00
"	12.	U. S. Exp. Co., Expressage,	90
"	5.	National Exp. Co., "	65
"	16.	H. D. Martin, labor,	3 00
"	20.	Andrus & Church, Stationery,	1 50
"	22.	H. P. Matthews, labor,	3 15
"	22.	F. H. Burnette, "	4 80
June	4.	H. P. Matthews, "	1 39
"	5.	F. H. Burnette, "	60
"	6.	N. D. Chapman, "	37
"	24.	Postmaster, Stamps,	5 00
		Total for Office Expenses,	$ 359 57

FOR AGRICULTURAL DIVISION.

1889.			
June	28.	J. Carbutt, Photo Plates,	11 16
July	1.	U. S. Exp. Co., Expressage,	85
May	31.	E. C. & N. R.R., Freight,	1 36
June	26.	Holstein Breeders' Ass'n, Registry fees,	1 00
July	30.	F. R. Wheeler, 1 Brood Sow,	10 00
"	30.	Chauncey Wade, labor,	2 00
Aug.	12.	James Seaman, repairs,	16 34
"	12.	C. U. Farm, labor,	15 83
"	17.	E. Tarbell, Freight bill,	2 34
"	17.	S. A. Seeley, 6 Hogs,	56 00
"	27.	C. J. Rumsey & Co., Hardware,	75
July	30.	I. P. Roberts, Expenses to Spencer,	2 33
Aug.	19.	E. Tarbell, " "	1 48
Sept.	1.	C. U. Farm, labor,	6 50
Oct.	1.	Treman, King & Co., Hardware,	48
"	3.	Enz & Miller, Paper Sacks,	1 50
"	1.	C. U. Farm, labor,	17 00
"	15.	*Country Gentleman*, Advertisement,	2 80
"	24.	James Jefferson, Shearing 31 Sheep,	4 00
"	29.	W. J. Ellis, 22 Sheep,	81 00
Nov.	1.	C. U. Farm, labor,	1 20
Oct.	31.	C. J. Rumsey & Co., Hardware,	4 55
"	3.	Jamieson & McKinney, Hose,	96
Nov.	19.	Bartholomay Brewing Co., Malt Sprouts, 5,600 lbs.,	28 25
"	20.	L. V. R.R., Freight,	5 88
Aug.	1.	E. C. & N. R.R., Freight,	80
Nov.	6.	Detroit Linseed Oil Co., 3 tons Oil Meal,	77 70
Dec.	5.	John Tice, labor,	8 00
"	1.	C. U. Farm, labor,	2 63
"	16.	National Exp. Co., Expressage,	60
1890.			
Jan.	1.	C. U. Farm, labor,	3 20
"	8.	J. D. Eagles, Photo Material,	3 10
"	10.	Gauntlett & Brooks, Photo Material,	46
Feb.	1.	C. U. Farm, labor,	8 50
Jan.	27.	Jamieson & McKinney, Plumbing,	4 00
"	3.	C. J. Rumsey & Co., Meat Cutter,	3 25
Feb.	22.	F. A. Drake, 3,870 lbs. Hay,	12 58
Mar.	1.	C. U. Farm, Labor and Oats,	9 02
		Amount carried forward,	$ 409 40

		Amount brought forward,	$ 409 40
Jan.	17.	E. G. Allen, Subscription to Periodicals, ...	10 30
Mar.	17.	E. C. & N. R.R., Freight, ...	1 07
"	10.	Bowker Fertilizer Co., 400 lbs. Meat Scraps, ...	7 28
"	20.	C. D. Stowell, Wool Sack, ...	45
"	31.	U. S. Exp. Co., Expressage, ...	60
April	1.	C. U. Farm, labor, ...	5 40
Feb.	12.	Treman, King & Co., Hardware, ...	6 65
April	9.	B. L. Bragg & Co., Seed Oats, ...	2 00
"	4.	L. V. R.R., Freight, ...	40
"	29.	James Jefferson, Shearing Sheep, ...	4 00
"	25.	J. E. Rice, labor, ...	1 20
May	1.	C. U. Farm, "	14 14
April	29.	E. C. & N. R.R., Freight, ...	2 28
May	20.	D. H. Burrell & Co., Seed Corn, ...	75
"	22.	U. S. Exp. Co., Expressage, ...	35
June	4.	Adams " "	2 00
"	6.	W. W. Root, labor, ...	1 20
May	22.	E. C. & N. R.R., Freight, ...	2 70
"	17.	Bowker Fertilizer Co., ½ ton Meat Scraps, ...	18 20
		Total for Agricultural Division, ...	$ 490 37

FOR HORTICULTURAL DIVISION.

1889.			
July	1.	C. U. Farm, labor, ...	8 75
"	5.	National Exp. Co., Expressage, ...	50
"	3.	J. Carbutt, Photo Plates, ...	8 10
"	6.	U. S. Exp. Co., Expressage, ...	1 05
"	3.	L. H. Bailey, Sundries and Postage, ...	6 11
"	5.	August Roelker & Sons, Fir Tree Oil, ...	1 00
"	5.	Adams Exp. Co., Expressage, ...	8 05
"	6.	James Vick, Insect Exterminator, ...	77
"	11.	National Exp. Co., .Expressage, ...	25
"	12.	S. R. Deane, 3 loads Manure, ...	2 25
"	1.	Burns Bros., Blacksmithing, ...	9 05
"	13.	Andrus & Church, Stationery, ...	2 50
"	10.	Adams Exp. Co., Expressage, ...	25
"	30.	Mail Carrier, 2 loads Manure, ...	80
"	10.	Gould's Mfg. Co., Nozzles, ...	1 50
"	12.	Field Force Pump Co., "	1 56
"	25.	Adams Exp. Co., Expressage, ...	45
"	13.	U. S. " " "	50
"	11.	Thos. Summerville & Sons, Nozzles, ...	1 00
"	18.	" " " "	1 50
"	31.	Pay Roll, labor, ...	99 72
"	8.	Field Force Pump Co., Nozzles, ...	1 50
"	17.	Atkins & Durbrow, Peat Moss Bedding, ...	15 00
"	17.	Eimer & Amend, Rubber Tubing, ...	2 52
May	4.	Fairbanks & Co., Glass Blower's Scale.	4 00
Aug.	7.	Andrus & Church, Letter-heads, ...	1 50
"	9.	M. J. Holmes, labor, ...	3 75
July	18.	W. A. Burpee & Co., Seeds, ...	1 82
Aug.	1.	C. U. Farm, labor, ...	4 35
"	12.	L. H. Bailey, Sundries, ...	4 10
"	17.	" " Freight bill, ...	5 89
"	10.	Hawkins, Todd & Co., 10 yds. Duck, ...	1 50
		Amount carried forward,	$ 201 59

		Amount brought forward,	$ 201	59
Aug.	16.	Judson & Co., Pot Labels,		35
"	13.	J. Carbutt, Photo Plates,	2	88
"	27.	" "	7	20
"	20.	Eimer & Amend, Bottles,	8	17
"	24.	Andrus & Church, Stationery,		27
"	29.	" " Manilla Bags,	4	42
"	31.	Pay Roll, labor,	73	31
"	31.	Andrus & Church, Stationery,	1	33
"	17.	Adams Express Co., Expressage,		65
"	28.	U. S. " " "		70
"	31.	National " " "		65
"	31.	U. S. " " "		65
Sept.	6.	U. S. " " "		35
"	2.	White & Burdick, Photo Material,	1	35
Aug.	30.	E. & H. T. Anthony & Co., Photo Material,	12	04
Sept.	13.	Andrus & Church, Stationery,	1	50
Aug.	9.	" " "		27
Sept.	9.	" " "	4	00
"	2.	Burns Bros., Blacksmithing,	2	35
"	12.	White & Burdick, Caustic Potash,		65
"	17.	E. & H. T. Anthony & Co., Photo Material,		58
"	30.	Pay Roll, labor,	84	56
"	28.	Andrus & Church, Stationery,	1	50
Aug.	30.	H. F. Dawson, 4 Top Props,	1	00
Sept.	6.	Rothschilds, 72 Bowls,	3	60
"	19.	C. H. Howes, Printing Photos,	1	29
Oct.	2.	L. H. Bailey, Sundries and Postage,	7	45
"	7.	U. S. Express Co., Expressage,		60
May	17.	A. D. Perkins, Rubber Stamp,	3	00
Oct.	8.	Andrus & Church, Pamphlet Cases,	2	50
"	5.	J. T. Lovett Co., Strawberry Plants,	3	88
Sept.	25.	National Exp. Co. Expressage,		50
Oct.	10.	" " " "		40
"	11.	W. M. Munson, Sundries,		67
"	8.	Syracuse Pottery Co., Flower Pots,	14	20
"	10.	Andrus & Church, Stationery,	1	48
"	8.	G. H. & J. H. Hale, Strawberry Plants,	1	50
"	15.	U. S. Express Co., Fxpressage,		40
"	15.	Guarantee Nursery Co., Trees and Plants,	17	46
"	10.	Adams Exp. Co., Expressage,	1	35
"	14.	E. H. Green, 25 bu. Oats,	9	25
"	9.	D. L. & W. R.R., Freight,	2	73
"	23.	National Express Co., Expressage,		40
"	31.	Pay Roll, labor,	55	84
"	15.	B. A. Westbrook, Huckleberry Plants,	2	00
"	4.	John Gardner & Co., Mushroom Spawn,	5	00
Aug.	30.	Jamieson & McKinney, Force Pump,	3	80
Oct.	25.	National Express Co., Expressage,		75
Nov.	8.	L. H. Bailey, 3 loads Sand,	2	00
"	16.	National Express Co., Expressage,	5	00
"	18.	" " " "		40
Sept.	25.	J. F. Moore, Harness Repairs,	5	20
Nov.	20.	W. M. Munson, Sundries,	1	30
"	15.	Jacob Manning, Plants,	6	00
"	30.	Pay Roll, labor,	35	23
Dec.	7.	White & Burdick, Sulphate of Copper,		80
		Amount carried forward,	$ 608	30

	Amount brought forward,	$ 608 30
Nov. 22.	Atkins & Durbrow, Peat Moss Bedding,	22 80
Dec. 12.	L. H. Bailey, Sundries,	1 30
" 2.	Kelly & Co., Oil and Matches,	64
" 13.	C. T. Stephens, Coal,	52 71
Nov. 23.	D. L. & W. R.R. Co., Freight,	11 08
Dec. 31.	Wm. Westcott, labor,	35 00
" 28.	National Express Co., Expressage,	45
" 5.	Burns Brothers, Blacksmithing,	2 85
" 13.	Henry A. Dreer, Seeds,	2 20
" 7.	D. L. & W. R.R. Co., Coal,	22 23
Nov, 2.	Treman, King & Co., Hardware,	19 93
Dec. 26.	George Small, Lumber,	36 23
1890.		
Jan. 4.	Henry Nuttall, labor,	6 00
" 4.	A. M. Hull, Feed,	13 18
" 3.	W. M. Munson, Sundries,	1 60
" 14.	A. W. Marston, labor,	4 62
" 14.	F. W. Card, labor,	1 72
" 16.	Fred Atwater, 12 loads Manure,	4 80
" 18.	National Express Co., Expressage,	45
" 31.	Wm. Westcott, labor,	25 55
Feb. 5.	Ithaca Gas Light Co., Gas for Jan.,	19
Jan. 28.	National Express Co., Expressage,	1 10
" 27.	Jamieson & McKinney. Plumbing,	10 04
" 21.	Kelly & Co., Oil,	1 44
Feb. 1.	F. W. Card, labor,	15 20
" 15.	W. M. Munson, Sundries,	1 74
" 12.	Andrus & Church, Stationery,	36
Jan. 29.	D. L. & W. R.R., Coal,	51 68
Feb. 28.	Peter Toner, labor,	15 00
" 28.	Wm. Westcott, labor,	33 30
Mar. 5.	Ithaca Gas Light Co., Gas for Feb.,	19
Feb. 5.	Gustav E. Stechert, Subscription to Periodicals,	11 00
Mar. 5.	J. M. Thorburn & Co., Seeds,	2 14
Feb. 27.	A. M. Hull, Feed,	8 67
" 27.	E. H. Green, 1,540 lbs. Oats,	14 92
" 18.	Andrus & Church, Stationery,	2 96
" 28.	Vilmorin, Andrieux & Co., Seeds,	6 45
Jan. 17.	E. G. Allen, Subscription to Periodicals,	10 39
Mar. 17.	L. V. R.R. Co., Coal,	33 15
April 1.	Wm. Wescott, labor,	35 00
" 1.	Peter Toner, "	10 00
" 4.	L. V. R.R. Co., Coal,	36 89
" 2.	W. M. Munson, Sundries and Postage,	5 70
Mar. 21.	Clayton Crandall, Horse Radish,	4 50
" 26.	Dennison Mfg. Co., Fish Glue,	1 35
" 20.	Hawkins, Todd & Co., 13 yds. Muslin,	78
" 28.	Robert Buist, Seeds,	75
April 9.	National Express Co., Expressage,	4 65
Feb. 27.	Gustav E. Stechert, Subscription to Periodicals,	6 75
April 11.	Andrus & Church, Stationery,	8 00
Mar. 7.	Burns Bros., Blacksmithing,	11 05
" 29.	Kelly & Co., Oil,	4 49
April 4.	Barr Bros., Plow Point,	95
" 4.	M. F. Pierson, Seed Potatoes,	1 50
" 7.	Adams Express Co., Expressage,	40
	Amount carried forward,	$1,226 32

		Amount brought forward,	$1,226 32
April	9.	J. Lewis Childs, Seeds,	65
"	14.	Hawkins, Todd & Co., Mosquito Netting,	5 00
"	8.	National Express Co., Expressage,	45
"	14.	Andrus & Church, Stationery,	2 00
"	20.	" " "	50
"	24.	National Express Co., Epressage,	95
"	24.	A. M. Hull, Feed,	6 00
"	22.	W. O. Little, 30 Apple Grafts,	3 00
"	29.	Treman, King & Co., Hardware,	37 85
May	1.	F. W. Card, labor,	10 60
"	1.	Wm. Westcott, labor,	35 00
April	28.	U. S. Express Co., Expressage,	65
May	7.	L. V. R.R. Co., Coal,	14 63
"	5.	Kelly & Co., Oil,	57
April	18.	J. M. Thorburn & Co., Grass Seed,	2 40
May	2.	J. J. H. Gregory, Seeds,	38
April	21.	U. S. Express Co., Expressage,	1 15
"	28.	Henry A. Dreer, Seeds,	55
May	3.	National Express Co., Expressage,	65
"	10.	W. M. Munson, Sundries and Postage,	2 55
"	2.	Pritchard, Edwards & Co., Repairs on Wagon,	3 25
"	10.	M. J. Holmes, labor,	3 00
"	10.	J. Lewis Childs, 2 Japan Wineberries,	2 00
"	13.	L. H. Bailey, Sundries,	2 03
June	1.	Wm. Westcott, labor,	36 35
May	24.	L. A. Hoyt, Collecting Case,	1 50
"	14.	Jamieson & McKinney, Plumbing,	23 80
April	26.	L. V. R.R., Freight,	2 68
June	9.	Andrus & Church, Stationery,	50
May	21.	" " "	1 50
"	14.	" " "	1 35
April	5.	Burns Bros., Blacksmithing,	2 05
June	4.	Mapes F. & P. G. Co., 500 lbs. Potassic Chloride,	10 00
"	2.	J. F. Moore, Harness Repairs,	1 45
"	12.	J. M. Thorburn & Co., Seeds,	75
"	24.	U. S. Express Co., Expressage,	85
"	6.	Gustav E. Stechert, Periodicals,	7 50
April	15.	S. R. Tisdell, Nozzles,	2 35
June	25.	Andrus & Church, Stationery,	88
"	14.	Detroit Paper Novelty Co., Berry Baskets,	10 13
"	25.	Samuel C. Moon, Botanical Specimens,	50
May	21.	Treman, King & Co., Hardware,	10 57
June	30.	Andrus & Church, Stationery,	1 70
"	31.	Pay Roll, labor,	55 20
		Total for Horticultural Division,	$1,533 74

FOR ENTOMOLOGICAL DIVISION.

1889.			
July	4.	L. V. R.R., Freight,	$ 2 30
"	2.	Whitehall, Tatum & Co., Bottles,	43 08
"	9.	Andrus & Church, Stationery,	45
"	16.	Syracuse Pottery Co., Flower Pots,	12 32
"	26.	U. S. Express Co.,	25
"	25.	Gauntlett & Brooks, Sundries,	64
"	25.	Truslow & Co., Corks,	4 16
		Amount carried forward,	$ 63 20

		Amount brought forward,	$ 63 20
Aug.	9.	G. W. Wescott, Sand and Lime,	1 75
"	17.	D. L. & W. R.R., Freight,	1 80
Sept.	24.	Treman, King & Co., Hardware,	9 83
Oct.	22.	Andrus & Church, Letter-heads,	3 75
"	19.	W. T. Falconer Mfg. Co., 1,000 Blocks,	2 50
Nov.	14.	Shephard & Dudley, Conductor's Punch,	3 35
"	12.	J. C. Stowell & Son, Barrel of Oil,	5 04
"	21.	M. V. Slingerland, labor,	21 30
Dec.	1.	Jennie Fleming, "	15 37
Nov.	26.	U. S. Express Co., Expressage,	60
Dec.	4.	U. S. Express Co., Expressage,	25
Nov.	22.	Gauntlett & Brooks, Sundries,	1 25
"	27.	James W. Queen & Co., Writing Diamond,	3 00
"	30.	Andrus & Church, Stationery,	2 00
"	26.	National Express Co., Expressage,	40
Dec.	4.	Bausch & Lomb Optical Co., Microscope Objective,	4 50
"	12.	Cook Brothers, Plants,	6 50
"	30.	Andrus & Church, Labels,	5 25
"	30.	Treman, King & Co.,	1 15
Jan.	1.	C. U. Farm, labor,	50
"	8.	J. D. Eagles, Photo. Material,	3 09
Feb.	11.	U. S. Express Co.,	1 50
"	10.	J. E. Jeffords & Co., Tiles,	11 83
Jan.	1.	L. V. R.R. Co., Freight,	50
Mar.	29.	M. V. Slingerland, labor,	18 00
"	21.	Andrus & Church, Letter-heads,	2 00
"	26.	A. B. Brooks, Plaster of Paris,	2 25
April	7.	Treman, King & Co., Hardware,	30
Mar.	27.	Andrus & Church, Stationery,	2 00
April	5.	Treman, King & Co., Hardware,	75
"	14.	Andrus & Church, Stationery,	90
"	4.	Hawkins, Todd & Co., 7½ yds. Swiss,	2 25
May	1.	M. V. Slingerland, labor,	12 15
April	24.	White & Burdick, Photo. Material,	4 20
"	24.	Bausch & Lomb Optical Co., Microscope Accessories,	1 71
"	18.	J. L. Barbour & Son, 6 lbs. Buhach,	4 50
May	10.	Hawkins, Todd & Co., 22½ yds. Swiss,	3 60
"	8.	W. J. Dominick, gathering Wire Worms,	4 00
"	10.	National Express Co., Expressage,	35
"	15.	A. B. Brooks, Sundries,	1 30
"	16.	Andrus & Church, Stationery,	2 25
"	24.	J. W. Queen & Co., Pins,	11 05
Dec.	7.	Jamieson & McKinney, Plumbing,	25
June	5.	H. N. Reid, Insecticides,	1 40
"	24.	Whitall, Tatum & Co., Bottles,	21 87
		Total for Entomological Division,	$ 267 29

FOR BOTANICAL DIVISION.

1889.			
Aug.	1.	Miss Jennie T. Martin, labor,	$ 14 60
"	12.	Miss Edna Porter, "	27 60
July	16.	Gustav E. Stechert. Books,	15 28
Sept.	5.	Haskin & Todd, Reagents,	4 13
Aug.	1.	Gustav E. Stechert, Books.	53 35
Oct.	1.	Miss Edna Porter, labor,	31 30
		Amount carried forward,	$ 146 26

	Amount brought forward,	$ 146 26
Aug. 12.	James Seamon, Repairs,	3 08
Sept. 5.	Miss J. T. Martin, labor,	4 00
Oct. 12.	G. E. Stechert, Books,	4 40
Dec. 9.	Miss Edna Porter, labor,	17 25
Oct. 22.	G. E. Stechert, Books,	2 12
1890.		
Jan. 3.	Adams Express Co., Expressage,	35
Mar. 21.	C. Scribner & Sons, Books,	67
June 6.	L. A. Hoyt, Apparatus,	2 55
" 16.	U. S. Express Co., Expressage,	70
May 16.	G. E. Stechert, Books,	14 53
	Total for Botanical Division,	$ 195 91

FOR CHEMICAL DIVISION.

1889.		
June 13.	L. V. R.R., Freight,	60
Sept. 26.	U. S. Express Co., Expressage,	35
" 27.	Troy Laundry Machine Co., Caustic Soda,	4 00
" 28.	D. L. & W. R.R., Freight,	50
Oct. 1.	National Express Co., Expressage,	25
" 14.	Emil Greiner, Apparatus,	16 90
Sept. 10.	Richard Kny, "	27 05
Oct. 1.	National Express Co., Expressage,	40
" 21.	L. V. R.R., Freight,	50
" 30.	" " "	50
" 22.	Andrus & Church, Stationery,	95
" 15.	Eimer & Amend, Apparatus,	5 81
" 29.	Treman, King & Co., "	3 50
Nov. 1.	C. U. Farm, labor.	60
Oct. 2.	Jamieson & McKinney, Plumbing,	1 00
" 29.	National Express Co., Expressage,	50
Nov. 27.	R. A. Heggie & Bro., Silver Dishes,	4 40
Dec. 5.	John Tice, labor,	7 90
Nov. 22.	Bullock & Crenshaw, Petroleum, ether,	6 40
" 25.	Eimer & Amend, Apparatus,	1 40
1890.		
Jan. 1.	Treman, King & Co., Apparatus,	13 78
" 14.	U. S. Express Co.,	30
" 13.	Emil Greiner, Apparatus,	10 20
	Total for Chemical Division,	$ 107 79
	Total expenditures,	$15,688 27